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CLOSING PRICE MANIPULATION AT THE HELSINKI EXCHANGES

- the effect of the evening trading

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Abstract
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CLOSING PRICE MANIPULATION AT THE HELSINKI EXCHANGES -THE EFFECT OF THE EVENING TRADING

PURPOSE OF THE STUDY

The purpose of this Study is to examine whether there exists closing price manipulation at the Helsinki Exchanges. Moreover, it is investigated whether brokers who have acquired or disposed large net positions during the day, manipulate closing prices to enhance their intraday performance measures. The Study also examines whether day-end returns are related to some sub-sample of the data, like different trading days of the year or high-volume stocks.

This Study is unique in a sense that the change in the evening trading rules at the Helsinki Exchanges in 2001 has opened an interesting window of opportunity to examine closing price manipulation in a new context. According to the new evening trading rules, the trading continues in the evening session with the same rules than in day's main trading session. The idea is to examine the effects of new evening trading opportunities on the possible manipulation of official closing prices, which are determined from the last observed transaction price of the main trading.

DATA

The data includes all trades made at the Helsinki Exchanges from August 3, 2000 to December 28, 2001. It consists of 4,382,376 trades, 352 trading days, 203 listed companies and 44 brokerage firms. Computer programming was used to handle such a large data set.

RESULTS

The results of this Study indicate that closing prices can be manipulated at HEX. The manipulation is likely to occur on certain days in a year and, in particular, when broker's net position has changed during the day. Moreover, the results imply that big buyers and sellers of the day manipulate closing prices to show better trading performance on an intraday-level.

Closing price manipulation has previously been linked more on the buy side meaning that closing prices would be manipulated upwards. The results of this Study indicate also that there can exist manipulation by brokers on the sell side as well.

KEYWORDS

Closing price, Day-end price, Closing price manipulation, Manipulation, Return anomalies, Action-based manipulation, Trade-based manipulation, Helsinki Exchanges

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PÄÄTÖSKURSSIMANIPULAATIO HELSINGIN PÖRSSISSÄ – ILTAKAUPAN VAIKUTUS

TUTKIELMAN TARKOITUS

Tämän tutkielman tarkoituksena on tutkia päätöskurssimanipulaatiota Helsingin Pörssissä. Tutkielmassa selvitetään manipuloivatko osakevälittäjät päätöskursseja parantaakseen päivänsisäisten kauppojen laskennallisia tuottoja, kun välittäjien osakekohtainen nettopositio muuttuu merkittävästi päivän aikana. Lisäksi, tutkitaan ovatko päivän lopun tuotot yhdistettävissä tiettyyn osaan datasta, kuten yksittäisiin päiviin vuodessa tai paljon vaihdettuihin osakkeisiin.

Helsingin Pörssin iltakaupankäynnin sääntöjen muuttuminen vuonna 2001 tarjoaa mielenkiintoisen mahdollisuuden tutkia manipulaatiota uudessa ulottuvuudessa. Kaupankäynti jatkuu uudistetussa iltakaupassa samoin säännöin kuin päiväkaupassa. Tutkielmassa tutkitaan, miten uudet kaupankäyntimahdollisuudet vaikuttavat mahdolliseen päätöskurssimanipulointiin. Viralliset päätöskurssit määritetään Helsingin Pörssissä päiväkaupan loputtua päivän viimeisistä kaupoista.

AINEISTO

Käytettävä aineisto sisältää kaikki tehdyt kaupat Helsingin Pörssissä 3.8.2000 ja 28.12.201 välisenä aikana. Näin ollen aineisto sisältää 4.382.376 kauppaa, 197 listattua yhtiötä ja 46 osakevälittäjää. Tietokoneohjelmointia käytettiin aineiston hallintaan.

TULOKSET

Tutkielman tulokset viittaavat siihen, että päätöskurssit ovat mahdollisesti manipuloinnin kohteena. Manipulointi näyttää olevan todennäköisintä tiettyinä päivinä vuodessa ja erityisesti silloin, kun välittäjän osakekohtainen nettopositio muuttuu päivän aikana. Näin ollen, välittäjät manipuloisivat päätöskursseja saadakseen päivän sisäiset kaupat näyttämään paremmin toteutetuilta.

Päätöskurssimanipulaatio on aiemmin yhdistetty enemmän osto- kuin myyntipuolelle eli päätöskursseja manipuloitaisiin ylöspäin. Tutkielman tulokset osoittavat myös, että myyntipuolellakin esiintyy päätöskurssimanipulaatiota.

AVAINSANAT

Päätöskurssi, Päätöskurssimanipulaatio, Manipulaatio, Epänormaali tuotto, Toimintapohjainen manipulaatio, Kaupankäyntipohjainen manipulaatio, Helsingin pörssi

1 Introduction

Stock closing prices are the most followed prices observed during a trading day. Mutual fund values are determined from closing prices. Academic researchers most commonly use the closing prices in their research work. In addition, the prices are used to evaluate broker or fund management performance and reported in major newspapers. Closing prices are used for these purposes because they are convenient and are generally assumed to present the true day-end share values. It would be alarming if the most important share prices of a trading day were subjected to manipulation by e.g. brokers, traders or equity fund managers.

The well-known phenomena of intraday trading anomalies have been a topic for an in-depth analysis in financial markets research for years. Recently, the increasing interest in possible stock price manipulation has heightened the need to investigate whether, in particular, the intraday return-anomalies are related to stock price manipulation. According to empirical evidence, day-end prices tend to rise significantly before the close and consequently, abnormal returns are observed. For instance, Harris (1989) shows that the last and second last transactions of the day have significant positive returns and more recently, Hillion and Suominen (2001) report that return anomalies are concentrated on the last five minutes of trading.

A key question still partly remains to be answered: are significant day-end price changes related to stock price manipulation? Several theoretical models address stock price manipulation in different contexts. For instance, Bagnoli and Lipman (1992) study manipulation through takeover bids and Allen and Gale (1992) examine manipulation through releasing of false information. However, until the end of 20th century, there were no models on closing price manipulation until Hillion and Suominen (2001) present an agency-based model on closing price manipulation that is consistent with observed day-end anomalies at Paris Bourse. In addition, Felixson and Pelli (1999) find slight evidence of closing prices manipulation (CPM) at the Helsinki Exchanges. In this thesis, CPM is defined as actions to artificially maintain certain price level near the day close to obtain private benefits.

After the attention that CPM phenomenon has received among academics and experts in the field, some exchanges have altered way closing prices are determined. For example, Paris Bourse has adapted call-auctions near the close in 1998.

1.1 Motivation

According to international evidence, the closing period is often quite different in terms of returns, volatility, volume and composition of order flow compared to the rest of the day. These anomalies suggest for the fact that closing prices are manipulated. However, the empirical results are still insufficient to support or reject CPM.

This Thesis study examines CPM empirically at HEX. HEX is an ideal market for this examination because the closing price is taken from the last transaction of the day. Many other exchanges, like Paris and Madrid, have adapted new closing price procedures like call-auctions and weighted-average calculation methods. Therefore, if an agent wanted to manipulate closing prices, her chances of doing so would be distinctly better at HEX than at other exchanges.

The introduction of new evening trading rules at HEX allows us to examine CPM in a new context. Closing prices are still taken from the last transaction of a day before the close (18:00), but trading is able to continue at 18:03 for three more hours with the same rules as during the day. As the prior evening trading rules allowed only for contract-based trading in certain price limits and volumes were quite modest, brokers were possibly sometimes forced to execute transactions just before the close to meet e.g. customers' orders for the day. This could have caused some of the previous stock price volatility in the closing period. As evening trading has been conducted at HEX on continuous basis since 11.4.2001, excess day-end returns can no longer be explained by interruption in trading opportunities. If we noticed sudden price movement upwards (downwards) before the close and then possibly downwards (upwards) in the evening trading session regardless of the new trading rules, CPM would turn out to be more noteworthy explanation to the day-end return anomalies.

1.2 Research questions

This study aims to find answers to the following questions:

- Are the trading anomalies in the closing period explained by CPM?

Recent studies report unusual trading patterns near the close [see, e.g., Hillion and Suominen (2001) and Thomas (1998]. These patterns seem to be related to market closure procedures and are consistent with the hypothesis of closing price manipulation.

- Do the different cross-sectional or time-series classifications presented in this Thesis provide new insight to CPM suspicions?

Previous research has related closing period anomalies to different cross-sectional and time-series classifications. For instance, month- or year-ends can be more convenient times for manipulation than normal trading days. This Study deepens the analysis by investigating intraday trading patters near the close while previous research has investigated the same phenomena from daily data.

- Is there evidence of broker involvement in CPM?

Latest articles on stock price manipulation address brokers' role in CPM. Hillion and Suominen (2001) present a theoretical model of broker manipulation. Felixson and Pelli (1999) report empirical evidence on broker manipulation at HEX.

- Does the analysis on the continuous evening trading session provide more insight to closing price manipulation?

The beginning of continuous evening trading at HEX provides a good opportunity to compare two different trading periods. It can be analysed whether the trading patterns near the day's close have changed when there is an opportunity to continue trading after a short interruption.

1.3 Limitations

This study does not consider all possible explanations to day-end return patterns. These uncovered topics are e.g. the effect of order flow, block trading and liquidity issues. Although none of these topics is related directly CPM, they can explain part of the observed abnormal day-end returns. As other return explanations are not fully considered, closing price manipulation could appear as too likely explanations to the day-end returns.

The changes in the order flow near the close can have significant influence over the day-end returns. For instance, institutional traders can shift their orders from the upstairs market to downstairs market just minutes before the day closing. This can lead to momentum price pressure resulting in positive day-end returns [see, e.g., Cushing and Madhavan (2000)]. On the other hand, Hillion and Suominen (2001) cast doubt over this theory. Block trading and end of the day liquidity have also been offered as explanations for high day-end returns [see, e.g., Felixson and Pelli (1999) and, Hong and Wang (2000), respectively]. Without detailed and consistent empirical evidence from the previous literature, these explanations are not considered in this Study.

1.4 Structure

This study begins with a review of stock manipulation literature. Chapter 3 summarises empirical results on intraday price anomalies and CPM. In addition, market efficiency theories are discussed in relation to CPM. Then, the hypotheses of this study are presented in Chapter 4. After that, data used in the empirical part of this study is presented in Chapter 5 and the methodologies are defined in Chapter 6. Then, empirical results of this study are presented and discussed in Chapter 7. Finally, the findings are summarised and ideas for further research are suggested in Chapter 8.

2 Theories of stock price manipulation

Despite that stock price manipulation has been an important issue in stock markets from the foundation of the first stock exchanges, manipulation has received relatively little attention in the financial literature. In addition, the literature is quite recent and surprisingly narrow. At first, the research concentrated on developing theoretical manipulation models, which though had foundations in previous literature other than manipulation literature itself. Only more recent studies have made empirical findings to support the theories and models.

At this point, it should be noted that manipulation differs from informed speculation [e.g., Admati and Pfleiderer (1998, 1999)] and insider trading [e.g., Fishman and Hagerty (1992)] in a sense that manipulation includes publicly observable actions designed to alter the stock price. Furthermore, Park (2003) describes stock price manipulation as different actions to manipulate stock price trough artificial pressure on supply and demand of a given stock.

Manipulation can be divided into two main categories: Action-based manipulation and trade-based manipulation. The distinction between the two categories is straightforward. In trade-based manipulation, the manipulation occurs through trading strategies. In action-based manipulation, the manipulator engages him to manipulative actions other than trading itself to affect asset prices. Action-based manipulation includes also information-based manipulation, which some research papers classify as a third manipulation form. In information-based manipulation, agents try to influence the stock prices by releasing false or misleading information. Closing price manipulation can be regarded as one form of trade-based manipulation although it has unique features that are not entirely consistent with a pure form of trade-based manipulation.

Given that manipulation literature is relatively narrow, following insight to the manipulation literature concentrates more to the individual researches than is accustomed in academic literature. Action-based and trade-based manipulation literatures are discussed separately. However, since the focus of this Thesis is on the closing price manipulation, it will be discussed as a separate entity from trade-based manipulation.

2.1 Action-based manipulation

Benabou and Laroque (1992) investigate manipulation through takeover bids. They formalise creditability and manipulation through a model of strategic information transmission that is based on Crawford and Sobel (1982), and Sobel (1985). In addition, Bagnoli and Lipman (1996) study is also related to games of reputation [see, e.g., Milgrom and Roberts (1982)] and Holmström's (1982) model of repeated moral hazard with learning about ability. Park (2003) extends the use of event studies to manipulation research. On the other hand, one event study related to action-based manipulation in Park (2003) can be seen as an empirical test on Benabou and Laroque (1992) paper.

Bagnoli and Lipman (1996) study discusses the use of privileged information to manipulate markets. Their study is related to Kyle and Vila (1991) whose model provides a link between financial markets and takeover activity. The previous research did not consider that manipulation is possible in relation with takeover activity until Bagnoli and Lipman (1996) introduced a model that allows for a profitable manipulation through takeover bids.

2.1.1 Using private information to manipulate stock markets

According to Benabou and Laroque (1992), access to private information has been shown to generate both incentive and ability to manipulate asset markets through deliberately distorted announcements. This kind of manipulation exists and can continue repeatedly since noisy privileged information interferes public's attempts to learn whether private announcements are honest or not.

Benabou and Laroque (1992) argue that privately informed individuals are able to gain more by both speculating and spreading information than corporate insiders are. This advantage gives private person an incentive to manipulate the market through biased messages. For instance, a person who is aware that the return on an asset is likely to be high can unnoticeably buy large amounts of it. Simultaneously, this informed individual could announce false statements, e.g. forecasting a low return on the asset. Factors such as intrinsic honesty, a sufficient fear for law, or concern for her reputation, can prevent a person from manipulating the asset price. However, these factors are not always strong enough to prevent manipulation as Texas Gulf Sulphur Company [1] and Emerson Radio Corporation [2] examples clearly show.

Benabou and Laroque (1992) illustrate the manipulation process by journalist's actions. A journalist is able to manipulate as long as the market considers her messages truthful and trades accordingly. The journalist uses her messages to influence market's perceptions of asset's value. If the journalist was caught lying and/or trading in the opposite direction compared to her messages, her reputation suffers and she is no longer able to manipulate. If successful, journalists' profits come from trading in the opposite direction compared to her public messages.

Benabou and Laroque (1992) state that a privately informed agent is able to use two different manipulation strategies. Pre-announcement speculation consists of trading in anticipation of the announcement's effect. In practise, the speculator first buys the asset and then announces positive news on its future value. According to the second scheme, post-announcement speculation, the speculator first releases misleading information to induce erroneous beliefs, and then trades based on her private information. These two schemes can also be combined to earn profits on both rising and declining market.

Park (2003) uses different kind of terminology over stock price manipulation. He identifies manifestation as one form of manipulation that refers to actions targeted to deceive investors by spreading or releasing information with the intention of misconception [3]. The manipulator can either circulate rumours about the asset value or deliberately invent rumours and news to affect stock prices. In both of these cases, the manipulator would gain if others trusted the manifestation.

(1) In late 1963, company's engineers struck huge mineral deposits. During the next six months, corporate officials engaged in a large-scale effort to convince the public that the opposite was true, by releasing false evidence. Mean while corporate officials accumulated company shares and options. Finally, company admitted that they have in fact found the mineral deposits.

(2) Company's top executives knew by December 1986 that incoming orders were shrinking while inventories were high and the sales of company's key products were declining. Nonetheless, they continued to make optimistic forecasts to shareholders and financial analysts until May 1987, when the company announced declines in sales. Company executives, some employees and various relatives and friends were selling 1.3 million shares in the six months before the announcement of the sales downturn.

(3) Park (2003) report a case in which a company announced an innovative invention in their field of expertise. However, later it become apparent that the invention did not have any approval of authorities due to negative health affects. In the mean time, company's stock price increased by 475% during one-month period.

2.1.2 Stock price manipulation through takeover bids

The announcement of a takeover bid leads normally to a significant increase in the target company's stock price. Bagnoli and Lipman (1996) present a model, which analyses the effects that a bid has on various market participants. Furthermore, they study the possibility that a takeover bid is motivated because of the bidder wants to profit from the announcement effect. Park (2003) also identifies public offerings as possible manipulation opportunities.

According to Bagnoli and Lipman (1996), the level of takeover activity is essential because it determines the profitability of manipulation. When takeover activity is low, manipulation profits are high. On the other hand, if the level of takeover activity is sufficiently high, manipulation profits are zero because the manipulators private information about the forthcoming bid is widely anticipated.

According to Bagnoli and Lipman (1996), there are certain conditions that should met before profitable manipulation is possible. First, the bidder would require large amount of capital since bidding costs are substantial. Secondly, the manipulator should have been able to acquire target's stocks before the announcement. Thirdly, the bidder must be able drop the bid and sell her stocks before the price declines after the bid is revealed as false. Fourthly, bidder's actions are not deemed as manipulation by the authorities governing the stock market. Note that the bidder can successfully manipulate the stock prices and avoid prosecution by conspiring (illegally) with others to trade in someone else's name.

2.2 Trade-based manipulation

Jarrow (1992) describes sufficient conditions, under which a price process is susceptible to profitable manipulation by large traders, as the traders significantly change their order flow to the market maker. In Gerard and Nanda (1993) model, manipulation is possible due to the interaction between secondary market trading before a seasoned offering and the pricing of the offering. The insiders can sell stock before the offering to lower the offer price and then, repurchase at this lower price in the offering. These two articles differ conceptually in a sense that in Jarrow (1992) the manipulator must not be an insider or an informed trader. Park (2003) presents different trading strategies that are aimed to artificially move the stock prices.

Khwaja and Atif (2003) show that manipulators can raise prices by attracting naive positive-feedback traders to the market and sell their own position when stock prices reach their peak.

Allen and Gale (1992) and later, Fishman and Hagerty (1995) consider manipulation strategies in which uninformed traders are able to manipulate due to market's misinterpretation of their assumed private information and observed trading behaviour. Allen and Gale (1992) study is related to manipulation around public offers when there exists uncertainty whether the offer is serious. Recently, Park (2003) has provided a complementary model to Allen and Gale (1992). On the contrary, Ilalan and Koray (2003) develop a model based on Allen and Gale (1992) that demonstrates how trade-based manipulation can be prevented.

Kose and Ranga (1997) investigate the impact of trade disclosure rule on the dynamic behaviour of insiders. They also show that the disclosure rule creates incentives for corporate insiders to manipulate the market by contrarian trading. Kose and Ranga (1997) model is similar to Fishman and Hagerty (1995) model in a sense that both models examine manipulation by an uninformed trader. In a sense, Kose and Ranga (1997) model is an extension to Fishman and Hagerty (1995) since it allows that also informed traders can manipulate.

Kyle (1984) and later, Kumar and Seppi (1992) discuss manipulative trading strategies in futures markets through trading strategies. Furthermore, Kumar and Seppi (1992) argue that uninformed manipulators can earn positive returns by trading in the spot market to manipulate a settlement price of a future contract. Kumar and Seppi (1992) model has similarities with Kyle (1985), but the existence of manipulation is assumed to be more general in the former model.

2.2.1 Market manipulation trading strategies

Jarrow (1992) investigates how large traders whose transactions affect prices can manipulate stock prices without risk under reasonable hypotheses of the equilibrium price process. Manipulation is possible because the larger trader is able to move stock price due to her trade size or alternatively, the asymmetry of information leads the market to believe that the trader is informed. In practise, large traders can manipulate the market either by cornering the market, or by generating first a price trend and then selling against it.

According to Jarrow (1992), to generate a market corner, speculator's shares must exceed the total supply in the market in a specific period. This is possible given that some traders have sorted the risky asset, and then effectively borrowed them from the speculator. Moreover, a short squeeze appears when the speculator reduces her holdings by calling in the shorts. At the same time, the speculator requires her broker for a physical delivery of all her outstanding shares. Next, the short traders must return the borrowed shares and since the speculator has cornered the market, they need to purchase the shares from the speculator. Therefore, the speculator is able to arbitrarily set the price and the manipulation profits come from those traders whose shorts are called.

Jarrow (1992) states that another way to obtain manipulation profits is to create a price trend (a bubble). To achieve this, a manipulator must have adequate market power. Secondly, she must be able to dispose her position before the bubble collapses. This procedure, establishing a trend and then trading against it, has similarities with the Delong et al. (1998) whose model suggests that a price process can exhibit differences in the inter-temporal price sensitivity i.e. as the price rises (falls), noise traders buy (sell) with a lag.

Jarrow (1992) also suggests that market phenomena like program trading and large anticipated changes in aggregate demand (e.g. due to in-the-money equity call options being exercised) or supply can potentially generate differences in the prise sensitivity that are favourable to market manipulation.

Park (2003) identifies three different sub-categories of trade-based manipulation. First, disguised trade refers to cases in which manipulator issues an improper matched order or a single-handed improper matched. In the former case, the order is a transaction at the same time with the same price and quality following collusion. In the latter case, the order is seemingly a normal transaction with the exception that the same person has placed the buy- and sell-order. Secondly, actual trades can also be used to manipulate the market if the sole purpose is to lead investors to misconception when the trades cause disequilibria of supply and demand in the market. Alternatively, investors may take the trades as a sign of forthcoming news on stock value. Thirdly, fixations and stabilisation can be seen as manipulative actions if they hinder market's price-setting function. Note that price stabilisation is usually allowed in relation to public offerings.

Khwaja and Atif (2003) consider price manipulation by brokers who purchase stocks for their own account. They find that these brokers earn higher profits compared to brokers who act only as intermediaries for outside investors. Manipulative brokers are able to attract naive positive-feedback traders to the market by starting trading back and forth in a given stock. As the brokers raise prices, outside investors chasing trend start buying the stock. After sufficient price increase, manipulative brokers are able to sell their own holdings at a higher price. Once the manipulative brokers leave the market, this artificially high price starts to decline and consequently, the price bubble bursts. Manipulation profits are taken from outside investors who trade via intermediary brokers.

2.2.2 Stock price manipulation in a market equilibrium with rational agents

Allen and Gale (1992) present a profitable manipulation model based on asymmetric information. Contrast to Jarrow (1992), there is a finite horizon framework i.e. bubbles are ruled out by construction and secondly, manipulation is possible without a market corner or price momentum. Profitable manipulation opportunity arises due to market's incomplete information about large trader's motives: the market does not know whether the trader is buying because the stock is undervalued or because she is trying to manipulate. This pooling will allow for profitable manipulation.

Manipulation mechanism in Allen and Gale (1992) is straightforward. They assume that there are two important agents: a manipulator and large trader. The informed large trader knows that, relative to her information, the stock is undervalued. At the same time, risk averse investors are willing to sell after a modest price increase, because they are uncertain about the real value of the stock and want to insure them against the increased risk. Eventually, the stock price rises because other investors do not know trader's real motives because of asymmetric information. In fact, other investors finally consider the trader to be informed about the stock value. Therefore, the trader can purchase at a lower price relative to her expectations and profits by selling later at a higher price. In conclusion, manipulator profits by imitating informed traders even though she has the same information as other investors.

On the other hand, Ilalan and Koray (2003) model show that if the information were symmetric, manipulation attempts would not be profitable. Other investors could wait until the value of a stock is publicly known and trade accordingly.

In a more recent work, Park (2003) expands Allen and Gale (1992) model by considering sell equilibrium as well. Allen and Gale (1992) had only considered profitable manipulation on the buy side and with rational investors. In sell (buy) side manipulation, traders manipulate the stock prices downwards (upwards). Park (2003) show that manipulation is possible on the sell side since manipulator is able to treat buy and sell equilibrium symmetrically.

Allen and Gale (1992), similar to Jarrow (1992), present a theoretical manipulation framework, but empirical questions still remains unanswered. According to Allen and Gale (1992), large traders frequently buy and then sell significant amounts of shares; even the traders seem not to be interested in taking over a company. They suggest that some part of the profits from this kind of activity can be result of manipulation described in their model.

2.2.3 Trading and manipulation around seasoned equity offerings

Gerard and Nanda (1993) investigate potential manipulation due to the interaction between trading in the secondary market before a seasoned equity offering (SEO) and the pricing of SEO. They argue that informed traders, acting strategically, can manipulate offering prices by selling stocks before SEO and consequently, profit from lower offering prices. Gerard and Nanda (1993) model is consistent with empirical SEO event studies. For instance, Lease et al. (1991) document significant excess returns two days before SEO, a significant issue discount and partial post-issue price recovery.

According to Gerard and Nanda (1993), a strategic trader with private information about the stock value can influence the offer price by trading in the secondary market before the bidding phase. This informed trader hopes to depress the secondary market price through her significant pre-offer sell activity. The trader can even have positive information about the stock value, but she still wants to sell her stocks in the secondary market to conceal her information in anticipation of the SEO. Such a strategy would be profitable only when the trader is able to recoup her secondary market losses through share purchases at a lower price in SEO.

Gerard and Nanda (1993) argue the manipulation opportunity arises because of the difference between the price setting mechanisms in the secondary market and SEO. As secondary market price is a function of the net order flow, an informed trader can affect secondary market prices by selling in the pre-offer market. On the other hand, stocks can be acquired at a fixed price in SEO regardless of the quantity demanded. Manipulation can occur when the informed investor expects to receive significantly more stocks in the SEO than the number of stocks she needs to trade in the pre-offer market.

2.2.4 Manipulation, market microstructure and asymmetric information

Glosten and Milgrom (1985) model does not allow for asymmetric information and therefore, manipulation is deemed impossible. On the contrary, Allen and Gorton (1992) show that asymmetric information can actually be the source for profitable manipulation. In addition, Chakraborty and Yilmaz (2002) show that if Glosten and Milgrom (1985) type of models, in which one insider is repeatedly trading, are expanded over larger amount of trading periods, manipulation would be possible if other investors were not sure whether they are trading against informed traders.

In Allen and Gorton (1992) model, manipulators are able to repeatedly buy stocks, causing a relatively significant effect on the stock price. However, manipulators sell with relatively smaller effect. This is possible due to the natural asymmetry between liquidity purchases and sales. Given that liquidity sales are assumed more likely than liquidity purchases, there is more information in a purchase than in a sale [4]. Therefore, bid prices move less after a sale than ask prices after a buy.

Kose and Ranga (1997) work is also related to the asymmetry of information. Their model shows that trade disclosure rules can courage an informed trader to manipulate the market by

(4) Previous literature, like Glosten and Milgrom (1985) and Kyle (1985), handles liquidity traders as asymmetric. However, Allen and Gorton (1992) state that it is difficult to understand the motivation for a trader who would have pressing needs to buy securities. A buyer can more freely choose the time of transaction compared to a trader who needs to sell shares because of an immediate need for cash.

contrarian trading i.e. buying (selling) when she has bad (good) news about the company. Consequently, the informativeness of insider's subsequent trade disclosures is reduced and the insider maintains her information superiority over the market for a longer period. Finally, the insider is able to collect profits (that are larger than the losses from the contrarian trading) in later periods by trading according to her truthful private information.

2.3 Closing price manipulation

CPM theories, consistent with other manipulation literature, have foundations in previous research and empirical findings. Especially, market intraday studies have been essential in creating the bases for CPM theories. Hillion and Suominen (2001) present a theoretical CPM model and provide empirical findings to support their hypothesis. Felixson and Pelli (1999) test their CPM model empirically at HEX. In addition, Kücükkocaoglu (2002) has tested the same model at the Istanbul Stock Exchanges. Nyman (1996) investigates CPM in relation to index option expiries. More recently, CPM has also received attention among practitioners and stock exchange authorities. For instance, Park (2003) article discusses the role of CPM in enhancing equity fund performance.

CPM differs from other forms of trade-based manipulation in a sense that it can occur due to agency reasons. Furthermore, there is a possibility that the manipulator does not have any position in the manipulated stocks and is still able to benefit from higher or lower day-end stock values. Felixson and Pelli (1999) consider the possibility that brokers manipulate closing price to alter their customer's inference of their execution ability. In addition, Hillion and Suominen (2001) suggest that traders can try to avoid margin requirements. Additional motivations to CPM can be addressed by considering the implications of closing prices. Both broker and trader compensation can be designed in a way that closing prices affect trader's commission from large customer orders. On the other hand, conflicts between exchange's trading rules and trader interest can lead to a situation where closing price are manipulated to ensure that certain trade can be executed at the desired price and time [5].

(5) In 1999, two brokers manipulated stock prices during the day at HEX to make sure that a significant stock acquisition could be executed in evening trading session as an internal trade. Evening trading rules of that time required that all evening trades were executed in a range of lowest and highest price from the day trading session. The two brokers extended this range during the day by trading far away from the prevailing price level. Finnish Court of First Instance convicted the brokers from stock price manipulation in 2001.

Before proceeding to CPM theories, it is essential to discuss the role of closing prices in modern financial world. (1) The closing price is probably the most closely followed stock price by investors and public, and quotes are reported in major newspapers and television news. (2) Academics and practitioners use closing prices to calculate returns in their research. Moreover, (3) broker or fund manager performance can be evaluated by using the closing price as a benchmark, and (4) closing prices are used to calculate mutual fund values. It is fair to assume that especially the latter two roles can facilitate CPM the most.

The role of closing price as benchmark to trader performance has been criticised by different authors. Berkowitz et al. (1988) show that since stock prices rise roughly two thirds of the day and consequently, buys appear to be executed better than sells. Moreover, Wood et al. (1985) and Cheung (1995) report that closing prices have different return distributions compared to prices observer during the day. These shortcomings of closing prices have led academics [e.g., Berkowitz et al. (1988)] to conclude that a volume weighted average price would be a better benchmark. However, intraday trading data is not usually available investors and brokers at a reasonable cost. Therefore, closing prices remain as convenient benchmark to trader or broker performance.

2.3.1 Closing price manipulation theories

Hillion and Suominen (2001) consider that agents whose performance is evaluated by a third party can manipulate closing prices to obtain personal benefits. A broker, who has executed a large buy (sell) order and noticed that the stock price has not moved into the undesired direction, can execute few trades near the close to drive the share price upward (downward). On the other hand, a broker may manipulate closing prices when an investment bank belonging to the same corporation has issued trade recommendations and the stock prices are not moving accordingly. Therefore, it can be argued that brokers can manipulate closing price for reputation reasons or alternative, to ensure a continuing relationship with the customer. Hillion and Suominen (2001) suggest also that brokers manipulate in hope for higher commissions in the future.

Felixson and Pelli (1999) argue that, because of CPM, returns before the close include a manipulation effect. Therefore, returns before the close are defined as:

$$\text{Return}_{t,close} = \text{normal return}_{t,close} + \text{manipulation effect}_{t,close} + \varepsilon_{t,close}, \qquad (1)$$

where returns before the close include a normal return, manipulation effect and random noise effect, respectively. The manipulation effect consists of both upward and downward price movements. Given that manipulation has occurred and that manipulators have no longer incentive to maintain a certain price level after the closing price are determined, stock prices returns to their true values. Therefore, returns after the close include a reversal effect as shown in Eq. (2):

$$\text{Return}_{t,close} = \text{Normal return}_{t,close} + \text{reversal effect}_{,close} + \varepsilon_{t,close}. \qquad (2)$$

Hillion and Suominen (2001) present a theoretical CPM model where brokers manipulate stock prices to alter their customers' inference of their trading ability. In the model, brokers set first their commissions for trading risky assets (stocks). Next, a customer observes the commissions and submits a block order to one active broker. The customer is not able to observe periodic shocks to the stock value although the price process is visible to all market participants. Therefore, the customer observes only the transaction price and closing price. To ensure ongoing relationship with the customer and obtain higher commissions in the future, the broker manipulates the closing price by selling (buying) a constant amount to (from) other traders who arrive to the market in the closing rounds of trading. It is rational to expect that customers would use the same broker if the closing price was high (low) enough compared to the transaction price when the customers had placed buy (sell) orders.

Hillion and Suominen (2001) formalise their model and argue that manipulation is an increasing function of customer's order size and a decreasing function of market liquidity. Secondly, they state that manipulation is an increasing function of broker's execution ability and volatility of asset return. As a result, manipulation should be related to large block orders, and secondly, to volatile and illiquid stocks.

In addition to manipulation by brokers, there can exist other situations where an agent would be tempted to manipulate closing prices. However, the past literature has not yet identified these possibilities. These additional CPM motives are presented alongside with this Study's Hypotheses in Chapter 4.

2.3.2 Closing price manipulation and efficient market hypothesis

This Chapter discusses CPM in relation to the hypothesis of efficient capital markets. According to the efficient market hypothesis, future stock prices should not be predictable. Stock price manipulation cannot be predicted from past security prices nor cannot it be predicted from publicly available information. Trade-based manipulation, more or less, exploits the behaviour of a normal investor. On the other hand, action-based manipulation requires private information. If profitable action-based manipulation is possible with the help of insider information, the strong form of efficiency does not apply.

CPM is difficult to predict with a complete certainty in individual cases, because it would require information about manipulator's private preferences. However, as the alterations to the closing mechanisms at the Paris Bourse and Madrid Stock Exchanges show, authorities have reacted to unusual trading patterns near the close i.e. to CPM. Therefore, it is also fair to assume that different market participants are aware of manipulative trading strategies near the close.

According to market efficiency theories, market frictions should be priced away and investors should not be able to earn abnormal returns in the long term. CPM is, however, distinct from market frictions in a sense that it is intentionally caused. Moreover, the manipulation effect is originated to affect the prices only before the close. After the close, when the manipulators have no longer an incentive to artificially sustain a certain price level, the prices return to their true values and follow again the random walk. Therefore, CPM can be considered as a market friction, which should be quickly priced away in efficient markets.

Moreover, Fried (2002) argues that CPM does not necessary harm any identifiable group although closing high would move stock prices away from their intrinsic value and consequently, the price discovery process would be affected. Fried (2002) suggests that authorities may deem the moving of closing prices through day-end purchases as an attack on the integrity of the market, and thus prohibited.

3 Review of previous empirical research

This Chapter presents different stock market anomalies and previous CPM-related empirical results. First, the seasonalities are discussed briefly. Secondly, the focus is on intraday trading patterns and anomalies. Thirdly, previous evidence from the closing period is presented.

3.1 Stock market anomalies - seasonalities

According to the day-of-the-week effect, returns are higher on Fridays compared to Mondays. Jaffe and Westerfield (1985) report that the weekend effect is persuasive across different world exchanges. Agrawal and Tandom (1994) find that the stock price volatility is highest on Mondays and lowest on Fridays. Furthermore, Martikainen and Puttonen (1996) report negative returns on Mondays, Tuesday and Wednesdays, but positive returns on Thursdays and Fridays in the Finnish stock market.

According to the turn-of-the-month effect, stock returns are higher around month-ends and especially, on the last day of the month. The effect has been detected from different markets [see, e.g., Lakonishok and Smidt (1988) for the US market, and Agrawal and Tandon (1994) for none US countries]. Martikainen et al. (1995) investigate the turn-of-the-month effect in the Finnish stock market and report that the effect is persuasive in Finnish stock, futures and index option markets.

The January effect, which represents the fact that stock returns are higher in January compared to other months, is usually explained by tax-loss-selling, information or turn-of-the-month liquidity hypothesis [see, e.g., Brown et al. (1983)]. Berglund (1986) reports that the Finnish month seasonalities are consistent with the other exchanges in the world and the January effects is similar regardless of companies' market capitalisation.

3.2 Intraday trading patterns

There exists an extensive literature, which addresses the empirical patterns of stock returns and market closures. Stoll and Whalley (1990) show that open-to-open returns are more volatile than close-to-close returns. In relation to the day-of-the-week anomaly, French (1980) finds that weekday returns are higher compared to weekend returns. In addition, according to

Amihud and Mendelson (1991), the intraday returns are more volatile than the returns over non-trading periods.

The availability of intraday price data has facilitated empirical research. Rogalski (1984) and Wood et al. (1985) report an U-shaped intraday return and volatility. Harris (1986) and Wood et al. (1985) find that stock price rise systematically towards the close. Furthermore, Harris (1986) reports that there is a general return increase on the last trade of the day. In addition, Jain and Joh (1998) find that intraday trading volume is U-shaped.

According to Harris (1986), day opening and day-end returns are five to ten times larger than mid-day returns. Furthermore, opening period returns accrue over several transactions and day-end returns accrue on the last trade. This phenomenon seemed to be pervasive for all trading days and companies of different sizes. Consequently, Harris (1986) concludes that the return generating process is different immediately after the day opening and near the close.

3.3 Stock returns and trading at the close

Price anomaly literature has identified several unusual time-series patterns in daily stock returns computed from closing prices. Harris (1989) finds evidence of systematic positive returns on the last trade of the day by investigating a transaction data of all NYSE stocks from 12/1981 to 1/1983. Furthermore, this phenomenon was more persuasive when the last trade occurred during the last five minutes.

The data included stocks, which were traded at both NYSE and the Pacific Stock Exchange (PSE). Since trading continued for one-half hour at PSE after NYSE closed, Harris (1989) investigates whether PSE stocks had different day-end returns compared to other NYSE stocks. Although PSE stocks had larger day-end returns compared to other times of the day, the returns were not significantly different from other NYSE stocks. Therefore, Harris (1989) concludes that the day-end effect seemed to be related to the closing period or events occurring before NYSE closes.

Furthermore, Harris (1989) analyse whether the day-end price rise is related to the weekday effect, January effect or turn-of-the-month effect. However, only the last trading day of the month had significantly larger returns compared to other days. Furthermore, the two year-end returns of Harris' (1989) sample were ranked as the second and ninth among the examined 296 daily returns. In addition, the other end-of-the-quarter returns were ranked as the 35th, 53rd, and 115th largest. These findings suggested to trading window relating to accounting data.

Harris (1989) uses three basic volume ratios to test whether the day-end returns were affected by last trade's size. Although he does not find any correlation between the returns and trade sizes, Jain and Joh (1988) report positive correlation between contemporaneous trading. Therefore, volume can play a certain role in high-volume period returns, but the trade-specific returns near the close are not necessarily explained by trading volume.

Cushing and Madhavan (2000) analyse day-end returns across all stocks of Russell 1000 – index from 7/1997 to 7/1998. To be more precise, they investigate whether institutional trading interest induces common component to day-end returns. It turns out that the end of the day explains a disproportionate fraction of the variation in daily returns. Furthermore, the phenomenon is more pervasive in the last five minutes and present especially in the largest marker capitalisation stocks. As institutions tend to concentrate their trade in the largest market capitalisation stocks and institutional trading was positively correlated with returns during the day, Cushing and Madhavan (2000) offer institutional trading as the most likely explanation to their findings.

Furthermore, Cushing and Madhavan (2000) investigate large order imbalances near the close to analyse changes in block trading in upstairs market. They found that there is a clear tendency that the frequency of imbalance indications increases alongside with trading volume. According to them, this suggests that the largest and most active stocks have the most severe imbalances. Furthermore, this is consistent with the sharp fall in large-block trading and a clear increase in non-block trading during the last five minutes. Therefore, the institutional traders demand higher immediacy in the regular "downstairs" market instead of the upstairs market. The following order imbalances can explain the sharp price movements at the end of the day.

Hong and Wang (2000) present a model of overnight market closure that explains increased price volatility and trading volume near the close. According to the model, informed traders who reduce their positions just before the close to avoid excessive overnight explain the phenomenon. On the other hand, Admati and Pfleiderer (1988) argue that liquidity traders who cluster their trades in downstairs market near the close explain the increased price volatility. Liquidity traders cluster the trades to reduce the adverse selection problem that they face when trading against informed traders. However, Hillion and Suominen (2001) findings cast doubts on these two explanations. They found that bid-ask spread increases significantly in the last minute. This suggests that the last minute is hardly the best time for liquidity traders. Furthermore, Hillion and Suominen (2001) argue that informed traders who want to reduce their overnight holdings would be better of by trading before the last minute.

3.4 Closing price manipulation evidence

Hillion and Suominen (2001) examine closing period anomalies at the Paris Bourse to support their CPM model. Their sample consists of CAC40 stocks from 1/1994 to 1/1995. Until 6/1998, similarly to the ongoing procedure at HEX, the closing price equalled the last transaction price of the day. From 6/1998 onwards, the closing call auction determined the closing price as the price, which allows the maximum executable volume to be reached for the submitted day-end orders.

Hillion and Suominen (2001) report striking increase in volatility near the close. The results are consistent with previous studies [see, e.g., Admati and Pfleiderer (1988)] that report the U-shaped intraday volatility. Previous studies, such as McInish and Wood (1990), identify an increase in day-end volatility. However, the studies have not been able to relate the increase to the last minute because the trading day has previously been divided into longer intervals. In Hillion and Suominen (2001) data, last minute's trades account for 2.5% of all trades. This amount is ten times larger than the unconditional average and over three times larger than the intraday high of the sample. Therefore, order submission rate and trading volume increase significantly near the close. Furthermore, the frequency of aggressive orders increase towards the close reaching the highest point just ten seconds before the close.

Traders may want to alter the market situation in terms of liquidity to rationalise trading at higher prices just before the close. Hillion and Suominen (2001) find that hidden orders rise suddenly at the market closure compared to all day situations. In this way, traders do not want advertise their imbalances to attract counter demand and instead, want to make the market look as thin as possible. Hillion and Suominen (2001) when referring to Thomas (1998) provide additional evidence of CPM from the Paris Bourse. Thomas (1998) reports that the market behaviour changed after the call auction was implemented to determine closing prices. The abnormal price volatility decreased and the CAC40 index did not show any longer abnormal volatility. Furthermore, the day-end returns were no longer different from the rest of the day. In addition, negative correlation with the daily returns disappeared. These findings indicate that the implementation of the call auction procedure has reduced CPM.

Hillion and Suominen (2001) report interesting observations from the Madrid Stock Exchange as well. After March 26, 1998, closing prices are calculated as a value-weighted average price of the last transactions whose lot size exceeds 500. Furthermore, when the last minute price change exceeds a certain limit, the closing price is a value-weighted average of the prices from the last five minutes. Hillion and Suominen (2001) investigate all trades during the last five minutes for both two months before and after the closing price mechanism changed. They find that the number of trades during the last 15 seconds decrease over 15% and interpret this as a sign of existing CPM. Moreover, the number of trades where the lot size is exactly 500 stocks increases from 318 to 598 during the same period. Consequently, these trades accounted for over 12% of all trades during the last 15 seconds and over 6% of all transactions during the last minute. Before the implementation of the new closing procedure, corresponding numbers were 5.6% and 3.5%. According to Hillion and Suominen (2001), the high amounts already before the new mechanism was implemented are probably caused by the fact that the change was announced one-month beforehand.

Felixson and Pelli (1999) investigate CPM at HEX from 1/1994 to 1/1995. If brokers have acquired large net positions during the day and at the same time, are active near the close, there is evidence of CPM. Moreover, Felixson and Pelli (1999) find that, especially, brokers who have acquired a big net position during the day drive closing prices upwards meaning that CPM is present on the buy side. However, the overall results are largely insignificant although regressions' dummy coefficients did get the expected signs.

Felixson and Pelli (1999) apply their model also to HEX evening trading to investigate whether stock prices return to their true values after CPM after the trading resumes. However, their model has an explanatory power close to null after the close. Felixson and Pelli (1999) state that this is caused by the fact that trades booked in the evening trading, at that time, were sometimes arranged already during the day. Therefore, the evening trading prices did not necessarily present the true prices. Although Felixson and Pelli (1999) examine also close – to-next-day-open returns, the results remain weak. Because over 18 hours was passed after the day closing, new information had arrived to the market and consequently, next morning's returns were very noisy. Felixson and Pelli (1999) carry out also robustness checks for the results before and after the close. However, the results stay virtually the same. In conclusion, their overall results after the close are insignificant, but the coefficients sings are consistent with CPM hypotheses.

Kücükkocaoglu (2002) applies Felixson and Pelli (1999) model to Istanbul Stock Exchange (ISE) with a slight exception in model's dummy variable definitions. In addition, the amount of stocks under examination is lower. Although the trading conditions are very different in the two exchanges, there are also signs of CPM by brokers at ISE. Overall, their results are weaker compared to the results of Felixson and Pelli (1999), but regression coefficients are right-signed.

It should be noted that Kücükkocaoglu (2002) results are reliable only before the close since he uses close-to-open prices to test the reversal effect. Similarly to Felixson and Pelli (1999), these returns are affected by the new information that arrives to the market after previous day's closing. One interesting observation is though that manipulation appears to be more likely on the sell side at ISE.

4 Hypothesis creation

The following hypotheses are mainly derived from the research material that was presented earlier in this paper. Some of Harris' (1989) hypotheses are tested with recent HEX data. Furthermore, Felixson and Pelli (1999) regression model is applied in this Study and their model is extended by examining selected brokers in detail. Time-series classifications of this Study have not been tested on an intraday-level in previous seasonalities literature.

The purpose of the empirical part is to examine 1) whether there exists CPM at HEX and furthermore, to analyse 2) what effects the start of continuous evening trading session had on possible CPM. The hypotheses and calculations are organised as follows. First, return and volume anomalies during the day and around the official closing time are identified at a general level. Secondly, the observed day-end anomalies are investigated in more detail in short time intervals and at a transaction level. Thirdly, internal trades where the same broker acts as both counterparts of a trade are examined. Fourthly, cross-sectional and time-series classifications are made to examine whether the results are caused by some sub-samples of the data. Alternatively, if these results at a general level fail to show manipulation, further characterisations of the data can reveal additional information. The General Regression Model (GRM) tests these classifications. Finally, manipulation by brokers is examined with the Broker Regression Model (BRM).

There should be abnormal returns and price volatility near the close that are not explained by e.g. volume considerations. These anomalies should be visible in short time intervals at the close, and more striking on the last transactions. After closing prices have been manipulated to a preferable direction, stock prices should return to their true values when the evening trading session begins.

Previous research has concentrated on the day-end anomalies and the focus has been in detecting CPM before the close. As there was a change in the HEX evening trading rules on April 11, 2001, the investigation can now be extended more theoretically correct fashion to the evening trading as well. Recent HEX data enables us to investigate CPM effects also after the official close in a continuous trading environment although closing prices are determined from the last trades of the primary trading at 18:00.

According to the new trading rules, trading continues three minutes after the official close on a continuous trading basis (18:03-21:00). New evening trading opportunities may have led to changes in investor behaviour and trading patterns near the close. As the empirical findings [e.g. Harris (1989) and Hillion and Suominen (2001)] show, there are significant stock price hikes near the close. Furthermore, intraday volume is normally U-shaped [e.g. Jain and Joh (1988)] meaning that there is high trading activity during the opening and closing period. These two findings indicate that the day-ends are hardly the best times to execute buy orders. As the new trading rules allow investors to postpone their trades to the evening trading session there should no longer be credible volume related explanations to high day-end returns. To examine what effects the new trading rules may have had on the last trading minutes, the hypotheses of this study are tested for 8 months prior and after the change.

4.1 Cross-sectional classifications

Characterisations of the data can reveal whether the return anomalies are caused by some specific sub-sample of the data. First, it is investigated whether internal trades where the same broker acts as the both counterparts explain the high day returns. Secondly, high trading volume days and stocks are examined in more detail. Thirdly, the effect of the market closure at one exchange when stocks' trading is able to continue in some other exchange is investigated. This examination is conducted with the HEX stocks that are also traded at NYSE.

Broker involvement

It is of interest to study in more detail trades where same broker acts as both counterparts. Manipulation would be easier in these internal trades since brokers can freely decide the price and the manipulator does not have to rely on another counterpart that the trade will be executed timely.

Manipulators surely do not want to be caught. Therefore, it is fair to assume that if brokers manipulated frequently in the internal trades, authorities would follow more closely these trades. Consequently, brokers may also be better off by manipulating in external deals. This way the brokers could justify higher or lower stock prices by e.g. market conditions. Nevertheless, the following hypothesis is tested in this Study. **Hypothesis 1:**

> H_0: Internal trades have equal day-end returns compared to all trades.
> H_1: Internal trades have different day-end returns compared to all trades.

Trading volume

Volume and liquidity reasons may explain large day-end price changes. Harris (1989) found that volume effects had no effect on the return anomalies near the close, but recent studies, e.g. Cushing and Madhavan (2000), indicate that volume and liquidity have influence over the returns. If trading volume was explained the day-end returns, CPM theory would not apply.

The impact of trading volume is examined by studying both specific days and companies with highest volumes. **Hypothesis 2:**

> H_0: Day-end return on the highest volume days and stocks is equal to normal average return of other days and stocks.
> H_1: Day-end return on the highest volume days or stocks is different from normal average return of other days or stocks.

Shares that are commonly included in equity funds may be subject to more intense manipulation. It would be convenient to drive up the value of an equity fund around the month-end and consequently, report higher monthly returns. In relatively small exchanges such as HEX, equity funds tend to concentrate on top turnover stocks. Therefore, the manipulation of equity funds, and not the high trading activity itself, can explain the high day-end returns of high volume stocks.

An equity fund can also be forced to sell stocks in the last phases of trading to meet margin requirements of an individual stock weight. In bullish markets, where growth stocks dominate the market, equity funds are loured to hold on to their "winner" stocks. When an equity fund has large relative share in a certain stock, which has risen considerably in a short time, the fund may be forced to sell some of its shares, perhaps near the close, to maintain their position within regulative limits. However, the Finnish market did not experience rapid hikes during the sample period used in this Study. Therefore, the possible negative day-end returns of high volume stocks are not likely to be explained by fund margin requirements in this particular sample.

Fried (2002), however, states that stock prices will quickly return to their true values unless manipulators are continuously able to close high. Therefore, in case of equity funds or capital investors, high closing can be seen as a shortsighted behaviour to attract investors or show better performance. Although Park (2003) reports about a case of continuing manipulative high closes (the RT Capital equity fund case in 2000), these kinds of actions cannot be considered as a very common. However, specific days of the year, like month-ends, may still be subject to CPM.

<u>HEX stocks traded also at NYSE</u>

According to Harris (1989), the large day-end price changes can be related either to the closure of one exchange itself or to the ending of all trading opportunities for the day. When trading is able to continue conveniently in some other exchanges, it can be argued that there should not be any major day-end price changes in the closing exchange. The number of HEX stocks traded at NYSE is relatively small, but sufficient to be examined. **Hypothesis 3:**

> H_0: Day-end return of HEX stocks traded also at NYSE is equal to normal average return of other stocks.
>
> H_1: Day-end return of HEX stocks traded also at NYSE is different from normal average return of other stocks.

If these stocks had same day-end return patterns than ordinary HEX stocks, the interruption of trading opportunities would not explain the day-end returns. Moreover, CPM would appear as a more likely explanation.

4.2 Time series classifications

Hillion and Suominen (2001) consider intraday manipulation by brokers. However, also other agents can have incentives for CPM. Companies can be interested in driving up their equity position's value and equity funds may boost their periodical performance. This can be achieved by issuing buy orders around e.g. the quarter-ends. On the other hand, by driving stock prices down on the very last minutes of the year, corporations may be able to lower capital gain taxes. **Hypothesis 4:**

> H_0: Day-end return in month-, quarter- and year-ends are equal to average normal returns of other trading days.
>
> H_1: Day-end return in month-, quarter- and year-ends are different from average normal returns of other trading days.

Previous seasonalities literature has reported that returns e.g. around month-ends are higher compared to other days in a month. However, the phenomenon has not been investigated at an intraday level. This enables us to examine whether the positive month-end returns accrue just before the close and thus can be a result of CPM.

Stock price manipulation has also been related to option trading. By manipulating the underlying asset price on the exercise day, it would possible to earn manipulation profits on the options. These kinds of actions are obviously dependent on trading rules. If exercise prices were derived from closing prices, CPM should also be investigated on option expiry dates. However, in modern option trading rules, such in use at HEX, the exercise price does no longer equal to the traditional closing price. The exercise prices are nowadays defined as different kinds of weighted-averages in a specific period on the exercise day. These kinds of measures have diminished the possibility of manipulation. Therefore, derivative settlement days are not examined in this Study.

Nyman (1996) investigates whether there exists manipulation in the index option markets at HEX. It was hypothesised that traders could increase the profits from their index options by manipulating the index option value on the exercise day. Nyman (1996) finds "circumstantial evidence" that stocks belonging to the FOX-index were manipulated. Trading volume and the amount of internal trades had sudden peaks on the option expiration dates. Although the observations were interesting, the modern way of calculating index and equity option values makes the same investigation with recent HEX data obsolete.

4.3 Examination of the manipulation and reversal effect

Closing prices are manipulated by driving the prices in the favourable direction before the close. This change in stock values is referred as the manipulation effect. Felixson and Pelli (1999) found evidence that share prices tend to increase (fall) near the close when a broker has acquired (disposed) a big net position during the day and the broker has pushed the prices into a preferable direction near the day-end. **Hypothesis 5:**

> H_0: Day-end return of a stock is the same regardless whether a broker has acquired or disposed a large net position in a stock during the day i.e. there is no manipulation effect before the official close
>
> H_1: There is a manipulation effect near the official close when a broker has acquired or disposed a large net position in a stock during the day

Since manipulators do not have an incentive to maintain the price level in the evening trading, stock prices return to their fair values and the reversal effect is observed. Felixson and Pelli (1999) found slight evidence of the reversal effect. However, their overall results were insignificant because they used evening trading prices, which were not good proxies of stock values. Former HEX rules allowed a trade to be reported in the evening trading although it could have been negotiated during the day. Therefore, the prices observed in the evening trading did not represent the true values. This problem is no longer present at HEX since the evening trading is conducted on continuous based after the change in the trading rules April 11, 2001. **Hypothesis 6:**

> H_0: Evening trading return of a stock is the same regardless whether a broker has acquired or disposed a large net position in a stock earlier in the day i.e. there is no reversal effect after the official close
>
> H_1: There is a reversal effect after the official close when a broker has acquired or disposed a large net position in a stock earlier in the day

Evening trading volume is lower compared with the rest of the day. Secondly, the anecdotal evidence from the market implies that brokerage firms tend to maintain relatively regular working hours for their traders regardless of the new evening trading session. Only few traders stay at the office and follow the market after the official close. However, as the descriptive statistics will later show, there is a significant trading activity immediately at beginning of the evening trading. Trading volume declines though sharply after the first half-hour. Since the reversal effect is investigated from the first 15 minutes of the evening trading, the lower trading volumes from 18:30 to 21:00 do not have influence over the results of this Study.

When illiquid stocks are manipulated, it is possible that there is no trading activity during the evening trading. Then, obviously the only CPM evidence can be found from day-end return patterns (i.e. from the observed manipulation effect).

4.4 The impact of new evening trading rules

The closing period has unique features; trading volume and return volatility increase at the same time when order flow to the market changes. Previous literature [e.g. Hillion and Suominen (2001)] has documented that changes in market closure procedures have effects on manipulative trading. For instance, after the Madrid Exchanges changed their closing price calculation mechanism, the day-end trading behaviour changed accordingly indicating to the continuing CPM. Now, the change in evening trading rules at HEX allows us to examine whether new trading opportunities after the official close have had influence over CPM.

By examining the periods before and after the start of the new evening trading, it is possible to discover changes in day-end returns. If the high returns were explained by volume related reasons, it would be possible to see lower returns after April 11, 2001, since trading has been able to continue three minutes after the official close on a continuous trading based. Surely, the traders who face unfavourably prices before the day closing can wait for the beginning of the evening trading to trade at more favourable prices once again. In light of the previous market evidence [e.g. Hillion and Suominen (2001)], the last minutes of the day are hardly the best times to execute buy orders. Therefore, the basic assumption in the evaluation is that the new kind of evening trading opportunities should have a decreasing effect on the high day-end returns. If there still exists significant end-of-the-day returns followed by opposite returns in evening trading, CPM could appear as a more likely explanation for the phenomenon. **Hypothesis 7:**

> H_o: The day-end return patterns remain the same regardless the change in HEX evening trading rules on 11.4.2001
>
> H1: The day-end return patterns are affected by the change in HEX evening trading rules on 11.4.2001.

5 Data

This Chapter first summarises main trading rules at HEX. Secondly, the data of this study is presented. Thirdly, used data processing methods are discussed briefly.

5.1 Trading at the Helsinki Exchanges

Stocks are traded at the Helsinki Exchanges according to an automated wholesale basis. Stock, subscription right and bond trading conducted by brokers are entered in the Exchanges' HETI trading system.

Stock trading is mainly based on orders issued by brokerage firms' customers. However, brokers can also act as broker-dealers and take own positions in securities.

Unit of trading

One unit of shares traded is referred as a lot, whose size is assigned by the Exchanges for each series of shares. Shares can also be traded in odd-lot sizes, but only on a contractual basis.

Tick size (minimum price fluctuation)

Stock prices change in tick. The minimum tick size is EUR 0.01.

Trading day

In general, all banking days are market days at the Exchanges. A trading day is divided into four trading segments based on the type of trading.

Opening of trading session 9:00-9:40 a.m.

In the opening period brokers enter their sell and buy orders into the HETI trading system. During the opening phase, the offer data are not yet public and the brokers are only able to observe their own offers. No actual trading takes place during the day-opening period.

The initial matching procedure is performed between 9:40-10:00 on a batch-trading basis. The sell and buy orders entered during the opening phase of trading are automatically matched as share transactions. Unmatched and odd lot size orders are directly transferred to next phase of trading, the continuous trading. In addition, opening (bid and ask) prices are quoted for each security.

Continuous Trading 10:00 a.m.-6:00 p.m.

Trading can be carried out as round lots, odd lots and negotiated deals. In round and odd lot-trading offers are matched on an automatic basis. Odd lot orders are matched when the bid is received and in every minute. The price level for odd lots is determined by the price of the last round-lot transaction. In negotiated deals, the seller and buyer negotiate freely the terms of transaction, although the trading price ranges between the highest and lowest price quoted during continuous trading. The official closing price for each stock and the closing HEX indices are confirmed at the end of continuous trading at 6.00 p.m.

After Market Trading I, 6:03-6:30 p.m.

Continuous Trading (Evening trading) 6:03-9:00 p.m., stage II
The same rules apply to evening trading as during continuous trading.

After Market Trading II 8:30-9:00 a.m. on the following trading day
In the after market trading stage, sell and purchase offers are not matched automatically and only negotiated deals are possible. The after market trading prices can fluctuate between the trading price ranges for round-lot trades during continuous trading. Transactions during evening trading and the best bid and ask price at the end of evening trading can widen the price range for deals in After Market Trading II.

5.2 Description of the data

The data set covers all stock trades from August 3, 2000 to December 28, 2001 in Helsinki Exchanges. The sample consists of 352 trading days that correspond to 176 days before and after the change in the evening trading rules April 11, 2001. All stocks that were listed in HEX during the sample period are included although some analyses are conducted for specific sub-samples of data. The data consists of 4,382,440 individual stock trades. 2,244,826 of these trades were executed before April 11, 2001 and 2,137,550 afterwards.

The intraday data includes entries for the date, time, trade type, amount of shares traded, price and involved brokers for every transaction. Trade type entry reveals whether a trade was executed in the upstairs or the downstairs market. Upstairs market consists of contractual and block trading and day-to-day trading is conducted in downstairs market. Since overnight returns are excluded from this study, stock splits and paid dividends were not controlled. The data was filtered for possible errors, like missing fields or miscoded data.

When large data sets are examined, it is possible that the results are affected by systematically miscoded or improperly reported data. These kinds of errors would have to be very subtle to adequately explain results of this study. In other words, to get biased results the errors would have to affect a significant fraction of the trading days. On the other hand, the errors have to be relatively small to go unnoticed by the data verification process. After a thorough examination of the data and acknowledging possible errors, the data can be expected to reflect the true trading information.

The final data includes entries for 4.4 million transactions and furthermore, several columns for each transaction. Therefore, the only meaningful way to handle such a large data is to use computer programming. Visual Basic Editor was used to perform the largest calculations in Microsoft Access database environment and Microsoft Excel was used as output platform for the results.

6 Methodology

BRM is based on the Felixson and Pelli (1999) model and at the same time, it tests Hillion and Suominen (2001) hypothesis as well. On the other hand, GRM investigates different time-series and cross-sectional classifications to test whether some specific sub-samples of the data explain the possible CPM.

Returns (r_t) are calculated as logarithmic price differences between two consecutive transactions [Wood et al. (1985)]. Intraday trade times are not considered in this Study although trades are not equidistant. In addition, overnight returns are excluded from the evaluation. Trade returns are defined as:

$$R_t = \ln (p_t / p_{t-1}), \text{ where} \tag{3}$$

p_t = the price of the security at time t

p_{t-1} = the price of previous trade

<u>General Regression Model</u>

GRM tests different cross-sectional and time-series hypotheses. I.e., the model investigates whether the day-end returns are related to specific sub-sample of stocks or trading days like month-, quarter- and year-ends. To examine the timing of CPM, returns of different periods before the close are examined. These periods vary from the last trading hour to last trading minute. GRM regression equation is as follows:

$$R(t)_{i,close} = \alpha + D_{MONTH} + D_{QUARTER} + D_{YEAR} + D_{NYSE} + D_{TOP20VOLUME} + D_{TOP30DAYS} + \varepsilon_t \quad (4)$$

where the intercept stands for a normal day-end return (from *i* time to close). $D_{MONTH,}$ $D_{QUARTER}$ and D_{YEAR} take the values of one on the last trading day of the month, quarter or year, respectively. These variables investigate whether different seasonalities accrue just before the day closing.

Harris (1989) investigate whether day-end returns are affected by the mere closing of one exchange if trading is able to continue at an another exchange or alternatively, are the returns patterns due to ceasing of all trading opportunities for one day. Since small proportion of HEX stocks are also quoted at NYSE, it is possible to replicate Harris (1989) examination and investigate whether these Finnish NYSE stocks experience different day-end trading patterns compared to other HEX stocks. D_{NYSE} takes the value of one in case of Finnish NYSE stocks.

Approximately 20 HEX stocks have over 100 daily transactions while majority of the stocks trade quite infrequently. These high volume stocks are used to test whether volume-related reasons explain the high day-end returns. Therefore, $D_{TOP20VOLUME}$ variable includes 20 most actively trade stocks during the sample period. To complete the volume analysis, high volume trading days are examined. $D_{TOP30DAYS}$ takes the value of one on 30 most active trading days. Expected signs for the regression coefficients are presented in Table 1.

Broker Manipulation Model

BRM investigates CPM by brokers. The focus is on brokers who purchase or sell a large net position during the day and then trade just before the close. To be more precise, these day-end trades are designed to make buys or sells of the day look better. In practise, brokers would push the closing prices upward (downward) when they have bought (sold) the stock. In this manner, broker intraday execution ability would appear to be better. These kinds of actions should be visible in stock prices in two different ways. There should be a manipulation effect before the close representing the stock price bias from the true values. Furthermore, as the prices return to their true values there should be a reversal after the official close. BRM dummy variable definitions stay the same for both of these periods. Only the regressed returns differ as the day-end returns are calculated from the period of 17:45-18:00 and evening trading returns are calculated from 18:03-18:18. Regression equation before the close is:

$$R(t)_{17:45,close} = \alpha + B_{all} + S_{all} + D_{BOTH} + \varepsilon_t, \tag{5}$$

where the intercept stands for the normal return before the close when big buyers or sellers of the day have not been active 15 minutes before the close or there have not been any large buyers or sellers during the day at all. B_{all} (S_{all}) captures cases in which a broker has acquired (disposed) large net position during the day and acts as the buying (selling) counterpart in the last 15 trading minutes. Therefore, B_{all} captures manipulation on the buy side and S_{all} on the sell side. As brokers' intraday trading prices can be evaluated against the closing price, BRM actually investigates whether brokers' day-end actions are aimed to enhance their intraday trading performance. Therefore, B_{ALL} and S_{ALL} variables are expected reveal whether there exists CPM by brokers. By definition, brokers are classified as large buyers or sellers when their intraday net position exceeds a certain cut-off value. Six different cut-off values are examined in this Study.

C_{ALL} dummy represents occasions where both the large buyer and seller have been active near the close. Therefore, the variable is designed to capture manipulation attempts both on the buy and sell side. This means that C_{ALL} consists of two different price movements and is therefore, likely tilted towards zero.

Eq. (6) is designed to capture the reversal effect by examining the evening trading returns (18:03-18:18). As the stock prices should return to their true values after the manipulation effect fades away, the model should get opposite results in the evening trading compared to the main trading session although the dummy variable definitions stay the same. Note that the evening trading returns observed before the trading rules changed on April 11, 2001 do not necessarily represent the true stock values since the deal could have been arranged earlier during the day, but just reported in the evening trading. This problem was present also in Felixson and Pelli (1999), but after the beginning of the continuous-based evening trading was launched on 11.4.2001, the stock prices reflect the prices of the recorded time.

$$R(t)_{close,18:18} = \alpha + B_{all} + S_{all} + D_{BOTH} + \varepsilon_t \qquad (6)$$

The dummy variable definitions play a crucial role in the BRM. Therefore, two different kinds of definitions are tested in this Study. These definitions are similar to those in Felixson and Pelli (1999). Model I captures cases in which the large broker has made the last trade of the day. However, it is possible that traders' manipulation attempts are not successful i.e. they fail to make the last trade. Model II considers this possibility by defining the broker activity near the close differently. Consequently, B_{ALL} (S_{ALL}) is defined as large brokers' buys (sells) divided by all trades during the last 15 minutes. D_{BOTH} variable definition remains unchanged.

Since the models are consistent with Felixson and Pelli (1999), the robustness checks would also be very similar. Robustness checks in Felixson and Pelli (1999) were: 1) the use of firm specific intercepts (returns), 2) the use of firm specific cut-offs (relative to trading volume), 3) controlling for block trades and 4) controlling for traders wanting to influence the bid-ask spread. Although the first test did not provide additional evidence in the previous study, firm specific returns are used to obtain as accurate results as possible. Firm specific relative cut-offs are not used in this Study since they did not alter the results in Felixson and Pelli (1999) study. Block trades and the widening of the bid-ask spread explained only a fraction of Felixson and Pelli (1999) results. The robustness checks lowered models' significance, but the coefficients had still the expected sings. The new evening trading rules have made the bid-ask spread robustness-test obsolete. Block trading is out of scope in this study since the focus is in the downstairs market.

In addition, the sample in this Study consists of 50 most active stocks while Felixson and Pelli (1999) test only 20 most active stocks. This increase of stocks is due to the growth in trading activity.

To deepen the analysis, BRM is extended for both before and after the close by examining whether the five most active brokers near the close are manipulating the closing prices. The regression equations of BRM extension are:

$$R(t)_{17:45,close} = \alpha + B_i + B_{other} + S_i + S_{other} + D_{BOTH} + \varepsilon_t \quad (7)$$

$$R(t)_{close,18:18} = \alpha + B_i + B_{other} + S_i + S_{other} + D_{BOTH} + \varepsilon_t, \quad (8)$$

where B_i and S_i are broker-specific dummies of the five most active brokers. These brokers are Evli, Enskilda Securities, Nordea, Alfred Berg and Opstock. B_{other} and S_{other} takes the value of one when other brokers are involved.

Table 1 Expected coefficient signs

Expected coefficient signs of GRM and BRM variables.
In GRM, the intercept stands for a normal return in a given period. D_{MONTH}, $D_{QUARTER}$ and D_{YEAR} take the value of one on the last day of the month, quarter or year. $D_{TOP20VOLUME}$ represent the 20 most active stocks and $D_{TOP30VOL}$ marks the 30 highest volume days. D_{NYSE} takes the value of one, when a stock is traded at both HEX and NYSE.
In BRM before the close, the intercept stands for a normal return in the last 15 minutes of trading when big buyers or sellers of the day have not been active during the last 15 minutes (17:45-18:00) or there have not been any big buyer or sellers during the day at all. B_{ALL} variable takes the value of one when a broker has acquired a big net position in one stock during the day, and acts as the buying broker near the close (17:45-18:00) in the last trade of the stock at hand. S_{ALL} variable takes the value of one when a broker has disposed a big net position in one stock during the day, and acts as the selling broker near the close in the last trade of the stock at hand. D_{BOTH} variable takes the value of one when both big buyer and seller make the last trade.
In BRM after the close, the intercept stands for a normal return in the first 15 minutes of evening trading (18:03-18:18) when big buyers or sellers have not been active 15 minutes before day closing or there have not been any big buyers or sellers during the day at all. B_{ALL} variable takes the value of one when a broker has acquired a big net position in one stock during the day, and acts as the buying broker near the close (17:45-18:00) in the last trade of the stock at hand. S_{ALL} variable takes the value of one when a broker has disposed a big net position in one stock during the day, and acts as the selling broker near the close (17:45-18:00) in the last trade of the stock at hand. D_{BOTH} variable takes the value of one when both big buyer and seller make the last trade.
In BRM extension, the coefficient signs and dummy definitions remain the same for all individual broker-specific dummy variables. These broker-specific dummies (B_i and S_i) are EVL=Evli, ES= Enskilda, NRD=Nordea, ALF=Alfred Berg, OPS=Opstock. Therefore, B_{OTHER} and S_{OTHER} stands for all other brokers.

Broker regression model

	Before the close	After the close
Intercept	(+)	(-)
B_{ALL}	(+)	(-)
S_{ALL}	(-)	(+)
D_{BOTH}	(+)	(-)

General regression model

	Before the close
Intercept	(+)
D_{MONTH}	(+)
$D_{QUARTER}$	(+)
D_{YEAR}	(-)
$D_{TOP20VOLUME}$	(+)
D_{NYSE}	(?)
D_{vol}	(+)

Broker regression model, extension

	Before the close	After the close
Intercept	(+)	(-)
B_i	(+)	(-)
B_{OTHER}	(+)	(-)
Si	(-)	(+)
S_{OTHER}	(-)	(+)
D_{BOTH}	(+)	(-)

7 Empirical results

The empirical results of this Study are presented in the following order. Descriptive statistics are shown to guide the reader to intraday and day-end trading conditions during the sample period. Secondly, the results of the GRM are reported. Thirdly, the findings from the BRM are offered. Finally, the possible effects of the evening trading rule change are discussed.

7.1 General observations of the data

The sample consists of 203 different stocks, 44 different brokers and 352 trading days. Table 2 divides the data into two sub-samples. Before-sample comprehends eight trading months before the evening trading rules changed 11.4.2001. Before sample represents the period of August 3, 2000 – April 9, 2001 and After-sample represents the period of April 11, 2001 – December 28, 2001.

The decrease in trading volume is due to the declining market trend through the whole sample period. In addition, the amount of stocks also decreased during the examined period. The decrease in trades between the two sub-samples was -4.8% while the trading volume decreased -14.4%. However, these two characteristics of the data do not have significant influence over the results since the attention in this Study is on intraday trading. Note that the two most active stocks' trading volume was 61.3% of the total trading volume (these stock being Nokia and Sonera).

Table 2 Data description

Trades -column includes all trades made in both downstairs and upstairs market. Volume € -column is the euro volume of these trades.
Before-sample represents the period before the change in the evening trading rules on April 11, 2001 (August 3, 2000 – April 9, 2001) and After-sample represents the period after the change (April 11, 2001 – December 28, 2001).

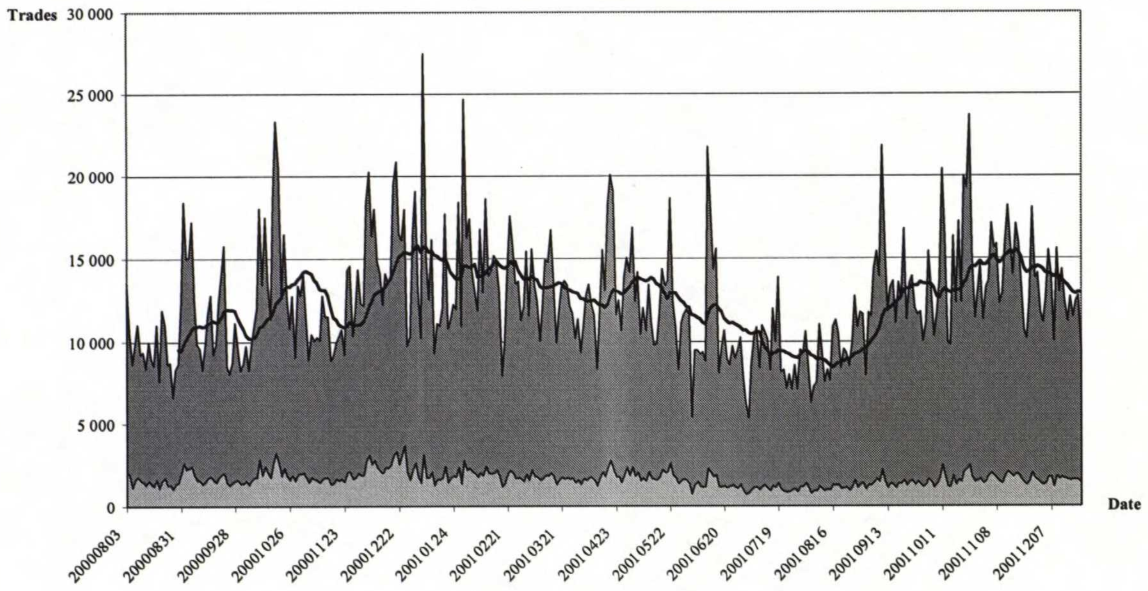
Period	Dates	Stocks	Brokers	Trades	Volume €
Before	176	198	36	2,244,826	156,150,000,000
After	176	182	38	2,137,550	133,613,000,000
All data	352	203	44	4,382,376	289,763,000,000

The amount of daily trades varies significantly during the sample period. Peaks in transaction volumes are related to quarterly announcements and especially, to large-volume stocks. Fig. 1

illustrates daily trades through the sample period. The lower coloured area of the graph shows internal trades where the same brokerage firm is selling and buying the stock.

Figure 1 Daily transactions

Daily trades during the sample period with a 20-day moving average (from August 3, 2000 to December 28, 2001). The lower grey area shows internal trades where the same broker acts as the both counterparts. "Trades" include all trades made at HEX downstairs and upstairs market during the whole sample period.



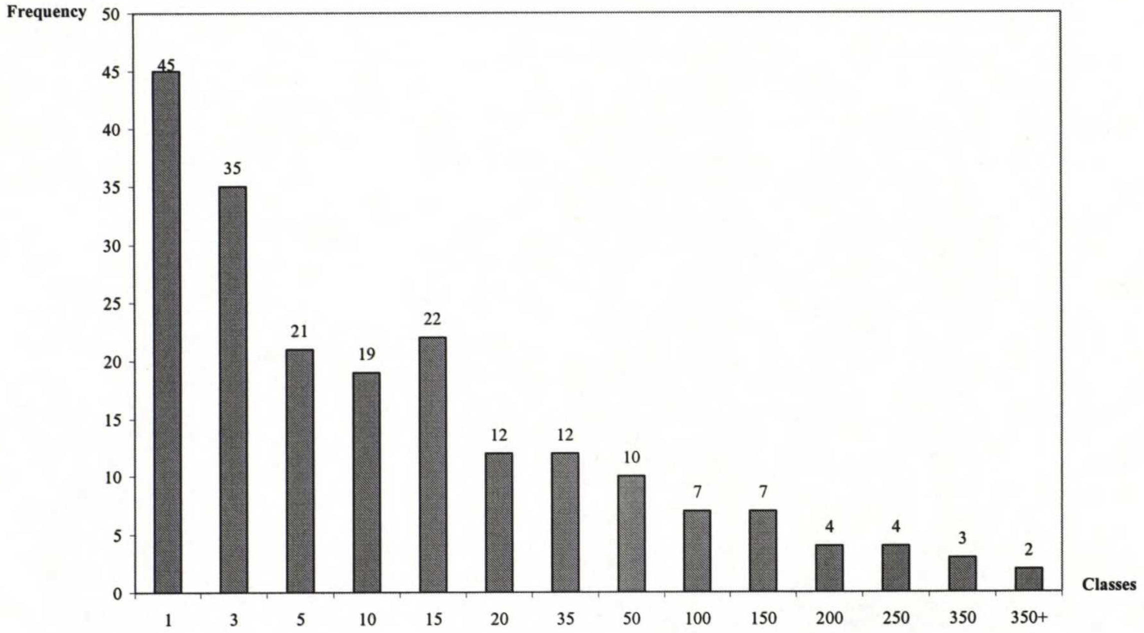
A considerable amount of the stocks has relatively small turnovers and in addition, the average of daily trades varies considerably between stocks. Fig. 2 shows that over 50% of the stocks have less than ten trades per day while the most active stocks are actively traded. Nevertheless, all calculations in this Study, expect for BRM testing, are conducted for all stocks. BRM is tested for the 50 most active stocks to ensure adequate intraday stock turnover for the investigated stocks. Furthermore, although some brokers had low trading volumes, the amount of brokers included was not restricted in this Study.

Fig. 3 shows that, consistent with the anecdotal market evidence, evening trading volume is modest compared to the main trading session. Still, there is a considerable trading activity especially during the first minutes (18:03-18:11). After the trading volume declines sharply around 18:30, the volume remains relatively low until the end of the evening trading.

Furthermore, Fig. 3 confirms the earlier reported fact that transaction volumes are lower in After-sample. However, it is interesting to observe that the start of the new evening trading has not significantly changed the day-end trading patterns. A large number of the daily

Figure 2 Average daily trades per stock

Frequencies of daily transaction averages per stock. Class "350+" includes Nokia and Sonera with a daily average of 5.242 and 1.700, respectively.



are still executed just before the official close although there is a real possibility to continue trading after the official close. One explanation to the decline in the last two hours can be that the opening of NYSE does not generate a trading peak at HEX to the same extent than before the evening trading opportunities were improved. Investors can now wait longer to see the trading at NYSE develops and trade accordingly in the evening trading.

According to Table 4, the average trade size increases towards the day-close. To minimize the cost of CPM, manipulators at HEX would probably make small trades just before the close. In this sense, the increasing trade size towards the close is of course problematic. However, if the brokers are the ones who are expected to manipulate the closing prices the most, they are not likely to spend their own wealth to the trades. Instead, they can just fill up their customers' orders for the day at higher or lower prices that would be needed. Therefore, the higher average trade size near the close may not play too crucial role in CPM examination.

The last trading hour and the first 15 minutes of the evening trading are presented in more detail in the Appendix A, which shows that returns and price volatility increase towards the close. In addition, the last trading minutes are very active and have the highest proportion of close. In addition, the last trading minutes are very active and have the highest proportion of positive returns compared to other times of the day.

Figure 3 Daily transaction volumes 8:30 – 21:00

Intraday transaction volume. Before-sample represents the period before the change in the evening trading rules on April 11, 2001 (August 3, 2000 – April 9, 2001) and After-sample represents the period after the change (April 11, 2001 – December 28, 2001).

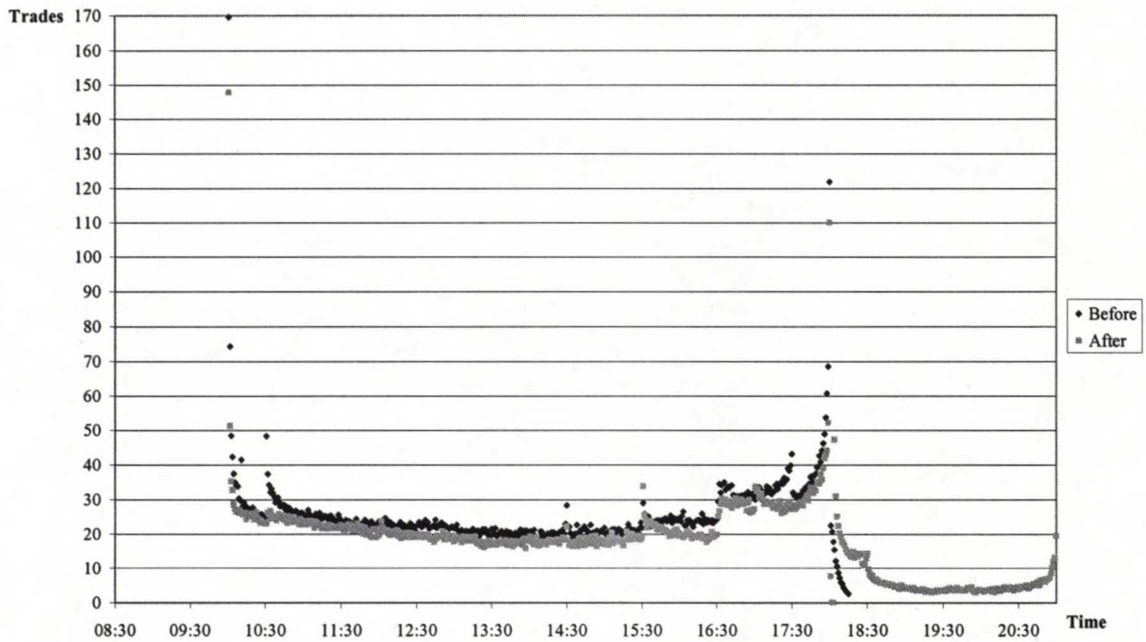


Table 4 Intraday trading statistics.

μ is one trade average logarithmic return. "μ < o", "μ = o", "μ > 0 ", indicate the proportion of trades that have negative, zero or positive returns, respectively. σ is the standard deviation of returns.
Before-sample represents the period before the change in the evening trading rules on April 11, 2001 (August 3, 2000 – April 9, 2001) and After-sample represents the period after the change (April 11, 2001 – December 28, 2001).

BEFORE

Period	Daily trades	Daily volume €	AVG lot size	AVG trade size €	μ <0	μ = 0	μ > 0	μ	σ
08:30-10:00	117	28,094,798	8,648.1	239,417.3					
10:00-11:00	1,953	97,251,753	1,829.2	49,787.7	13.2%	74.5%	12.3%	-0.000043	0.00567
11:00-12:00	1,441	76,735,678	2,124.9	53,243.9	13.4%	73.8%	12.9%	-0.000044	0.00519
12:00-13:00	1,354	80,438,955	2,277.6	59,429.6	13.4%	74.0%	12.6%	-0.000029	0.00535
13:00-14:00	1,229	68,943,788	2,276.7	56,106.0	13.4%	73.9%	12.8%	-0.000013	0.00523
14:00-15:00	1,234	70,803,696	2,377.0	57,396.4	13.6%	73.7%	12.7%	-0.000020	0.00548
15:00-16:00	1,355	84,484,477	2,450.2	62,331.6	13.5%	73.8%	12.7%	-0.000064	0.00498
16:00-17:00	1,670	124,304,996	2,709.8	74,423.0	13.6%	73.5%	12.9%	-0.000043	0.00479
17:00-18:00	2,258	170,119,951	2,860.5	75,345.5	14.1%	72.1%	13.8%	0.000002	0.00572
18:00-19:00	145	91,564,093	25,203.3	629,847.6	16.6%	67.1%	16.3%	-0.000528	0.03604
19:00-20:00									
20:00-21:00	160	12,573,883	2,779.5	78,793.8	13.7%	73.3%	13.0%	-0.000042	0.00442

AFTER

Period	Daily trades	Daily volume €	AVG lot size	AVG trade size €	μ <0	μ = 0	μ > 0	μ	σ
08:30-10:00	78	19,872,028	21,168.7	253,587.4					
10:00-11:00	1,659	76,735,423	2,570.9	46,241.7	13.0%	74.2%	12.8%	0.000003	0.00588
11:00-12:00	1,311	64,513,324	2,930.8	49,191.8	13.2%	74.1%	12.7%	-0.000035	0.00529
12:00-13:00	1,179	61,184,852	3,013.8	51,899.8	13.0%	74.2%	12.8%	0.000014	0.00548
13:00-14:00	1,061	52,687,809	2,972.4	49,657.0	12.8%	74.5%	12.7%	-0.000011	0.00610
14:00-15:00	1,073	55,328,988	3,110.0	51,580.6	13.1%	74.3%	12.7%	0.000005	0.00599
15:00-16:00	1,219	69,601,786	3,275.7	57,078.8	13.2%	74.1%	12.8%	-0.000046	0.00548
16:00-17:00	1,439	95,416,612	3,592.5	66,313.9	13.4%	73.6%	13.0%	-0.000047	0.00580
17:00-18:00	1,949	136,234,403	3,829.9	69,905.8	13.6%	72.8%	13.6%	0.000007	0.00499
18:00-19:00	639	109,590,333	9,938.0	171,566.9	17.3%	65.5%	17.2%	0.000016	0.01667
19:00-20:00	221	5,638,303	1,627.1	25,475.4	14.8%	70.3%	14.9%	0.000088	0.00855
20:00-21:00	314	5,784,976	1,323.8	18,417.5	14.9%	69.9%	15.3%	0.000082	0.00811

Two different statistical tests are performed for the returns in this Study. T-test for a sample mean is calculated as shown in Eq. (9). The statistic is compared to Student's t-distribution with n-1 degrees of freedom.

$$t = \frac{(x - \mu_0)}{\frac{s}{\sqrt{n}}}, \text{ where} \tag{9}$$

t = t-statistic

x = the sample mean

μ_0 = the assumed mean

s = the standard deviation of the sample

n = the sample size

Z-test is used to determine whether the proportions of positive returns are statistically significant. The proportion is calculated as positive returns / (positive + negative returns). The assumed mean (μ_0) and proportion of positive returns (p_0) are shown alongside the results whenever applicable.

$$Z = \frac{(p - p_0)}{\sqrt{\frac{p_0(1 - p_0)}{n}}}, \text{ where} \tag{10}$$

z = z-statistic

p = proportion of the elements in the sample belonging in calculated class

p_0 = proportion of the elements assumed to belong to calculated class

n = the sample size

Returns of the last ten trades are presented in Table 5. The results show that the returns are positive and larger than all-day returns. In addition, the proportion of positive returns is significantly high on the last trade. When the whole sample period is considered 52.3% of last trades are positive compared to all-day mean of 49.2%. Similarly, last trade's average return is 0.097% compared to all day average of –0.0022%. Therefore, the possible manipulation is likely to happen only on the last trade of the day. CPM does not appear to begin already on preceding trades since the returns of second last trades are more negative than positive. It is noteworthy that last returns' level of confidence is very high for both t- and Z-statistics. Therefore, it can be concluded that there is a clear upward return peak on the last trade.

Table 5 Statistics of last ten last trades of the day

Average return statistics of the last ten trades before the official day closing. Panel A includes all trades from the main trading session (10:00-18:00). Panel B presents the same information in one-hour interval before the close (17:00-18:00). Count includes all trades and "Pos+Neg" includes trades whose returns are distinct from zero. "Pos%" takes the value of positive returns / (positive + negative returns). μ is the average return and σ is the standard deviation of returns. T-statistics is compared to Student's t-distribution with n-1 degrees of freedom. Z-statistics are calculated to test whether the proportion of positive returns differs statistically from negative returns. The proportion is defined as positive returns / (positive + negative returns). μ_0 is the assumed mean and P_0 is the assumed proportion of positive returns in the given period. Significance levels above the 90% level of confidence are marked with bold.
Before-sample represents the period before the change in the evening trading rules on April 11, 2001 (August 3, 2000 – April 9, 2001) and After-sample represents the period after the change (April 11, 2001 – December 28, 2001).

BEFORE

	Count	Pos&Neg	σ	μ	μ_0	t-statistic	Pos%	P_0	z-statistic
Panel A: 10:00-18:00									
Last trade	20,872	10,479	0.0194	0.000901	-0.00003	**6.94**	51.5%	48.8%	**5.59**
-2	19,130	8,821	0.0155	-0.000191	-0.00003	-1.43	47.5%	48.8%	**-2.47**
-3	17,620	7,916	0.0138	-0.000102	-0.00003	-0.69	47.8%	48.8%	-1.78
-4	16,406	7,168	0.0128	-0.000214	-0.00003	-1.84	47.3%	48.8%	**-2.56**
-5	15,384	6,491	0.0124	-0.000048	-0.00003	-0.18	47.6%	48.8%	-1.91
-6	14,557	6,199	0.0117	-0.000134	-0.00003	-1.06	47.5%	48.8%	**-2.10**
-7	13,844	5,874	0.0111	-0.000281	-0.00003	**-2.66**	48.2%	48.8%	-0.97
-8	13,168	5,466	0.0114	-0.000067	-0.00003	-0.37	48.0%	48.8%	-1.24
-9	12,600	5,218	0.0105	-0.000183	-0.00003	-1.65	46.7%	48.8%	**-2.99**
-10	12,103	4,968	0.0103	-0.000285	-0.00003	**-2.73**	47.4%	48.8%	-1.93
Panel B: 17:00-18:00									
Last trade	14,097	7,516	0.0171	0.000755	0.000002	**5.24**	51.6%	49.5%	**3.71**
-2	11,192	5,505	0.0125	-0.000260	0.000002	**-2.22**	48.1%	49.5%	**-2.03**
-3	9,414	4,450	0.0110	-0.000177	0.000002	-1.58	48.1%	49.5%	-1.89
-4	8,152	3,780	0.0097	-0.000046	0.000002	-0.45	49.4%	49.5%	-0.18
-5	7,198	3,207	0.0102	-0.000140	0.000002	-1.19	47.4%	49.5%	**-2.43**
-6	6,457	2,822	0.0089	-0.000023	0.000002	-0.23	48.6%	49.5%	-0.98
-7	5,853	2,584	0.0076	-0.000091	0.000002	-0.94	50.3%	49.5%	0.85
-8	5,380	2,266	0.0072	-0.000003	0.000002	-0.06	47.9%	49.5%	-1.51
-9	4,972	2,138	0.0070	-0.000179	0.000002	-1.84	47.2%	49.5%	**-2.14**
-10	4,637	1,981	0.0070	0.000051	0.000002	0.47	49.5%	49.5%	0.01

AFTER

	Count	Pos&Neg	σ	μ	μ_0	t-statistic	Pos%	P_0	z-statistic
Panel A: 10:00-18:00									
Last trade	19,289	8,698	0.0199	0.001061	-0.000013	**7.51**	53.2%	49.5%	**6.85**
-2	17,586	7,494	0.0180	0.000104	-0.000013	0.86	49.0%	49.5%	-0.86
-3	16,117	6,601	0.0169	0.000086	-0.000013	0.74	48.1%	49.5%	**-2.29**
-4	14,944	6,065	0.0134	-0.000133	-0.000013	-1.10	48.7%	49.5%	-1.28
-5	13,948	5,501	0.0114	-0.000264	-0.000013	**-2.59**	47.0%	49.5%	**-3.71**
-6	13,112	5,073	0.0116	-0.000169	-0.000013	-1.55	47.7%	49.5%	**-2.62**
-7	12,433	4,750	0.0109	-0.000160	-0.000013	-1.50	48.3%	49.5%	-1.70
-8	11,812	4,354	0.0105	-0.000187	-0.000013	-1.80	47.8%	49.5%	**-2.25**
-9	11,274	4,191	0.0100	-0.000134	-0.000013	-1.29	47.8%	49.5%	**-2.21**
-10	10,815	3,903	0.0108	-0.000195	-0.000013	-1.76	47.9%	49.5%	**-1.98**
Panel B: 17:00-18:00									
Last trade	12,244	5,875	0.0156	0.000983	0.000007	**6.92**	53.7%	49.9%	**5.69**
-2	9,715	4,263	0.0122	0.000052	0.000007	0.36	49.4%	49.9%	-0.70
-3	8,126	3,439	0.0092	-0.000164	0.000007	-1.67	48.5%	49.9%	-1.69
-4	6,988	2,923	0.0092	-0.000096	0.000007	-0.93	48.5%	49.9%	-1.51
-5	6,067	2,426	0.0078	-0.000242	0.000007	**-2.50**	47.0%	49.9%	**-2.91**
-6	5,414	2,155	0.0076	-0.000179	0.000007	-1.81	47.6%	49.9%	**-2.16**
-7	4,913	1,920	0.0063	-0.000165	0.000007	**-1.91**	48.1%	49.9%	-1.59
-8	4,459	1,708	0.0064	-0.000181	0.000007	**-1.96**	48.4%	49.9%	-1.31
-9	4,111	1,558	0.0062	-0.000113	0.000007	-1.25	47.7%	49.9%	-1.78
-10	3,785	1,356	0.0051	-0.000120	0.000007	-1.53	47.4%	49.9%	-1.86

Table 6 shows the last trade's returns classified by the trade time. It is apparent that the returns increase as the trade time is near day closing. Similarly, the proportion of positive returns rises constantly towards the last minute although statistical significance of the average returns appears to decline. This can imply that CPM efforts are concentrated on the last 5-10 minutes and the manipulation appears to be stronger on the buy side. The results are also consistent with the Hillion and Suominen (2001) conclusion that the last minutes are hardly the best times to execute buy orders.

The standard deviation of returns declines unexpectedly towards the close. If there existed a large scale CPM, the standard deviation would probably increase instead as manipulator trade away from the prevailing market prices. High-volume stocks dominate the sample, especially before the close. Furthermore, as these stocks get zero returns on consecutive trades more frequently than other stocks, the decline may not affect CPM suspicions too severely.

Table 6 Last returns classified by the trade time

Average return statistics of the last trades before the official day closing classified by trade time.
Count includes all trades and "Pos+Neg" includes trades whose returns are distinct from zero. "Pos%" takes the value of positive returns / (positive + negative returns). μ is the average return and σ is the standard deviation of returns. T-statistics is compared to Student's t-distribution with n-1 degrees of freedom. Z-statistics are calculated to test whether the proportion of positive returns differs statistically from negative returns. The proportion is defined as positive returns / (positive + negative returns). μ_0 is the assumed mean and P_0 is the assumed proportion of positive returns in the given period. Significance levels above the 90% level of confidence are marked with bold.
Before-sample represents the period before the change in the evening trading rules on April 11, 2001 (August 3, 2000 – April 9, 2001) and After-sample represents the period after the change (April 11, 2001 – December 28, 2001).

BEFORE

Period	Count	Pos&Neg	σ	μ	μ_0	t-statistic	Pos%	P_0	z-statistic
17:59-18:00	3,953	2,248	0.0138	0.00143	0.00040	**4.69**	55.5%	52.8%	**2.61**
17:58-18:00	4,905	2,753	0.0139	0.00148	0.00032	**5.85**	55.4%	51.9%	**3.62**
17:55-18:00	6,578	3,633	0.0141	0.00131	0.00020	**6.39**	54.6%	51.0%	**4.34**
17:50-18:00	8,126	4,437	0.0144	0.00119	0.00013	**6.60**	53.8%	50.6%	**4.24**
17:45-18:00	9,143	5,003	0.0154	0.00110	0.00009	**6.23**	53.1%	50.3%	**3.93**
17:40-18:00	9,941	5,415	0.0155	0.00100	0.00008	**5.96**	52.9%	50.2%	**4.01**
17:30-18:00	11,339	6,150	0.0165	0.00089	0.00004	**5.51**	52.4%	49.8%	**4.03**
17:20-18:00	12,734	6,856	0.0166	0.00086	0.00003	**5.61**	52.2%	49.7%	**4.06**
17:10-18:00	13,511	7,235	0.0168	0.00080	0.00002	**5.41**	51.8%	49.7%	**3.58**
17:00-18:00	14,097	7,516	0.0171	0.00076	0.00000	**5.24**	51.6%	49.5%	**3.67**

AFTER

Period	Count	Pos&Neg	σ	μ	μ_0	t-statistic	Pos%	P_0	z-statistic
17:59-18:00	3,662	2,027	0.0127	0.00145	0.00037	**5.14**	56.3%	52.7%	**3.19**
17:58-18:00	4,424	2,399	0.0134	0.00151	0.00028	**6.10**	55.7%	52.1%	**3.53**
17:55-18:00	5,896	3,067	0.0139	0.00146	0.00020	**6.95**	55.0%	51.6%	**3.81**
17:50-18:00	7,374	3,733	0.0144	0.00130	0.00013	**7.02**	55.1%	50.8%	**5.21**
17:45-18:00	8,306	4,145	0.0145	0.00123	0.00010	**7.06**	54.9%	50.6%	**5.49**
17:40-18:00	9,022	4,461	0.0146	0.00116	0.00008	**7.06**	54.8%	50.6%	**5.64**
17:30-18:00	10,081	4,946	0.0147	0.00119	0.00005	**7.74**	54.8%	50.3%	**6.24**
17:20-18:00	10,952	5,332	0.0148	0.00112	0.00003	**7.66**	54.4%	50.1%	**6.19**
17:10-18:00	11,651	5,619	0.0150	0.00109	0.00002	**7.71**	54.2%	50.0%	**6.29**
17:00-18:00	12,244	5,875	0.0156	0.00098	0.00001	**6.93**	53.7%	50.0%	**5.66**

The same broker acts as both the selling and buying counterpart in 15.2% of trades. Brokers can decide the stock prices more freely in these internal trades compared to external trades. Therefore, the internal trades are excellent manipulation opportunities. However, the internal deals are not different from the external deals in terms of return statistics as Table 7 shows and consequently, H_0 of Hypothesis 1 is accepted. In fact, the internal deals get weak, negative average returns and the proportion of positive returns is below 50% in almost every period. As shown in the Appendix B, returns of internal trades are in most cases different from the assumed means in absolute terms, but the amount of observations is too low for statistical conclusions. Therefore, the results imply that if the closing prices are manipulated upwards, this is more likely to happen in external deals. Brokers who manipulate surely do not want the get caught and can decide to manipulate in external trades so that they can justify their trades by market conditions. Consequently, CPM would more likely go unnoticed by the authorities.

Note that statistical tests have so far been made by setting the assumed mean (μ_0) and proportion of positive of returns (p_0) to particular period's comparable average return and proportion positive of returns, respectively. Since short intervals are examined, these measures could also be set to μ_0=0.000 and p_0=50.0%. However, the significance of the result would not have changed drastically.

U-shaped intraday volume and return patterns are also present at HEX. CPM can be considered as one potential explanation for the high day-end returns. However, it is still possible that high closes can be a result of normal trading behaviour. Statistically positive last trade returns arouse CPM suspicions. On the other hand, internal trades, where manipulation is relatively easy, show below average returns. Therefore, to verify CPM suspicions, further characterisation of the data is needed. GRM's results shall next point out whether CPM can be related to certain days in a year or to different cross-sectional classifications.

Table 7 Return Statistics of Internal Trades

The trading intervals from which the statistics are calculated are presented in Panel's headline.
Count includes all trades and "Pos+Neg" includes trades whose returns are distinct from zero. "Pos%" takes the value of positive returns / (positive + negative returns). μ is the average return and σ is the standard deviation of returns. T-statistics is compared to Student's t-distribution with n-1 degrees of freedom. Z-statistics are calculated to test whether the proportion of positive returns differs statistically from negative returns. The proportion is defined as positive returns / (positive + negative returns). μ_0 is the assumed mean and P_0 is the assumed proportion of positive returns in the given period. Significance levels above the 90% level of confidence are marked with bold.
EVL = Evli, ES = Enskilda, NRD = Nordea, ALF = Alfred Berg and OPS = Opstock.
Before-sample represents the period before the change in the evening trading rules on April 11, 2001 (August 3, 2000 – April 9, 2001) and After-sample represents the period after the change (April 11, 2001 – December 28, 2001).

BEFORE

	Count	Pos&Neg	σ	μ	μ_0	t-statistic	Pos%	P_0	z-statistic
Panel A: 10:00-18:00									
EVL	33,451	12,827	0.00388	-0.00006	-0.00003	-1.62	46.2%	48.8%	**-5.81**
ES	14,922	6,395	0.00662	-0.00012	-0.00003	-1.72	48.3%	48.8%	-0.76
NRD	112,694	36,555	0.00644	-0.00014	-0.00003	**-5.79**	48.6%	48.8%	-0.68
ALF	20,078	7,032	0.00526	-0.00009	-0.00003	-1.63	47.1%	48.8%	**-2.77**
OPS	16,337	5,924	0.00696	-0.00002	-0.00003	0.18	49.1%	48.8%	0.43
Panel B: 17:00-18:00									
EVL	6,935	2,813	0.00515	-0.00002	0.000003	-0.41	49.4%	49.5%	-0.13
ES	2,900	1,545	0.01247	-0.00023	0.000003	-1.01	49.8%	49.5%	0.19
NRD	14,635	5,519	0.00759	-0.00013	0.000003	**-2.19**	49.6%	49.5%	0.11
ALF	3,567	1,336	0.00910	-0.00008	0.000003	-0.51	47.6%	49.5%	-1.41
OPS	1,722	704	0.00899	-0.00022	0.000003	-1.02	50.6%	49.5%	0.55
Panel C: 17:45-18:00									
EVL	1,843	710	0.00356	0.00007	0.00009	-0.27	52.5%	50.3%	1.20
ES	788	432	0.01266	-0.00002	0.00009	-0.24	50.0%	50.3%	-0.12
NRD	4,356	1,760	0.00794	-0.00039	0.00009	**-4.03**	49.9%	50.3%	-0.34
ALF	953	342	0.00725	0.00023	0.00009	0.58	50.9%	50.3%	0.22
OPS	443	195	0.00967	-0.00054	0.00009	-1.38	53.8%	50.3%	0.99

AFTER

	Count	Pos&Neg	σ	μ	μ_0	t-statistic	Pos%	P_0	z-statistic
Panel A: 10:00-18:00									
EVL	14,421	5,393	0.00433	-0.00015	-0.00001	**-3.85**	46.2%	49.6%	**-4.88**
ES	10,775	4,065	0.00341	-0.00012	-0.00001	**-3.39**	46.0%	49.6%	**-4.61**
NRD	75,424	23,935	0.00763	0.00001	-0.00001	0.76	49.6%	49.6%	0.21
ALF	16,412	5,411	0.00332	-0.00009	-0.00001	**-2.86**	48.1%	49.6%	**-2.10**
OPS	13,300	4,506	0.01011	-0.00012	-0.00001	-1.25	48.2%	49.6%	-1.86
Panel B: 17:00-18:00									
EVL	2,749	1,056	0.00378	-0.00012	0.00001	-1.73	47.1%	50.0%	-1.88
ES	1,864	718	0.00353	-0.00016	0.00001	**-2.06**	46.8%	50.0%	-1.69
NRD	9,659	3,403	0.00645	0.00008	0.00001	1.18	50.9%	50.0%	1.13
ALF	2,792	929	0.00361	-0.00006	0.00001	-1.00	49.1%	50.0%	-0.53
OPS	1,256	471	0.01021	-0.00040	0.00001	-1.41	48.0%	50.0%	-0.86
Panel C: 17:45-18:00									
EVL	873	331	0.00459	0.00026	0.00010	1.02	52.6%	50.6%	0.70
ES	572	212	0.00408	-0.00003	0.00010	-0.76	49.5%	50.6%	-0.33
NRD	2,959	1,122	0.00596	0.00014	0.00010	0.34	52.9%	50.6%	1.48
ALF	891	311	0.00320	-0.00007	0.00010	-1.61	48.6%	50.6%	-0.74
OPS	386	136	0.01558	-0.00055	0.00010	-0.82	49.3%	50.6%	-0.32

7.2 General regression model

This Chapter presents results of GRM. Regression variables are discussed in light of this Study's hypotheses and previous empirical results. GRM return statistics are shown in Table 8 and regression results in Table 9. The model captures the well-known phenomenon that stock prices tend to increase before the close. The results will also show that a part of the day-end returns is explained by time-series classifications. Furthermore, volume related explanations to high day-end returns are compromised. Although the data has some limitations in terms of a large number of illiquid stocks, the amount of observations was sufficient to conduct the tests.

Table 8 Return statistics of GRM

D_{MONTH}, $D_{QUARTER}$ and D_{YEAR} represent the last day of the month, quarter or year, respectively. $D_{TOP20VOLUME}$ represent the 20 most active stocks and $D_{TOP30VOL}$ marks the 30 highest volume days. D_{NYSE} represents the stocks, which are traded at both HEX and NYSE. "None of the above" stands for a normal return in the given period.
Count includes all trades and "Pos.+Neg." includes trades whose returns are distinct from zero. "Pos%" takes the value of positive reruns / (positive + negative returns). μ is the average return and σ is the standard deviation of the returns. T-statistics is compared to Student's t-distribution with n-1 degrees of freedom. Z-statistics are calculated to test whether the proportion of positive returns differs statistically from negative returns. The proportion is defined as positive returns / (positive + negative returns). μ_0 is the assumed mean and P_0 is the assumed proportion of positive returns in the given period. μ_0 and P_0 of each panel are presented on the "All returns" row. Significance levels above 90% level of confidence are marked with bold.
Before-sample represents the period before the change in the evening trading rules on April 11, 2001 (August 3, 2000 – April 9, 2001) and After-sample represents the period after the change (April 11, 2001 – December 28, 2001).

	BEFORE							AFTER						
	Count	Pos&Neg	σ	μ	t-statistic	Pos%	z-statistic	Count	Pos&Neg	σ	μ	t-statistic	Pos%	z-statistic
Pane A: 17:00-18:00														
D_{MONTH}	682	348	0.0357	0.001650	1.17	51.0%	1.53	495	278	0.0251	0.004097	**3.43**	56.2%	**2.82**
$D_{QUARTER}$	336	185	0.0387	0.004891	**2.29**	55.1%	**2.56**	167	94	0.0298	0.006864	**2.88**	56.3%	1.67
D_{YEAR}	115	53	0.0493	-0.001966	-0.44	46.1%	-0.43	57	31	0.0222	0.006625	**2.18**	54.4%	0.69
$D_{TOP20VOLUME}$	3,420	1,727	0.0170	0.000639	**2.04**	50.5%	**2.82**	2,710	1,446	0.0146	0.000962	**2.65**	53.4%	**3.68**
$D_{TOP30DAYS}$	1,414	662	0.0283	-0.000641	-0.91	46.8%	-0.96	627	314	0.0261	-0.000089	-0.30	50.1%	0.13
D_{NYSE}	1,004	515	0.0152	0.000679	1.32	51.3%	**2.03**	837	465	0.0145	0.001411	**2.38**	55.6%	**3.32**
None of the above	6,897	3,218	0.0292	-0.000387	-1.23	46.7%	**-2.38**	5,414	2,576	0.0292	-0.000366	-1.47	47.6%	**-3.30**
All returns				0.000047		48.1%					0.000219		49.8%	
Pane B: 17:30-18:00														
D_{MONTH}	587	296	0.0344	0.001883	0.75	50.4%	0.37	418	228	0.0244	0.002492	0.90	54.5%	1.21
$D_{QUARTER}$	302	162	0.0362	0.004177	1.61	53.6%	1.38	145	73	0.0295	0.004760	1.36	50.3%	-0.30
D_{YEAR}	103	44	0.0450	-0.003203	-0.91	42.7%	-1.41	46	23	0.0241	0.006567	1.45	50.0%	-0.21
$D_{TOP20VOLUME}$	3,182	1,647	0.0144	0.000836	0.04	51.8%	**2.36**	2,535	1,348	0.0122	0.001201	-0.90	53.2%	1.61
$D_{TOP30DAYS}$	1,163	573	0.0260	0.000488	-0.44	49.3%	-0.27	516	267	0.0266	0.001294	-0.11	51.7%	0.08
D_{NYSE}	938	485	0.0131	0.000640	-0.43	51.7%	1.25	804	452	0.0117	0.001405	-0.03	56.2%	**2.63**
None of the above	4,876	2,358	0.0287	0.000627	-0.48	48.4%	-1.83	4,111	2,066	0.0273	0.001482	0.15	50.3%	-1.70
All returns				0.000825		49.7%					0.001418		51.6%	
Pane C: 17:45-18:00														
D_{MONTH}	473	230	0.0355	-0.000853	-1.31	48.6%	-1.15	387	207	0.0240	0.002920	1.02	53.5%	0.59
$D_{QUARTER}$	238	114	0.0382	-0.003228	-1.82	47.9%	-1.04	132	63	0.0306	0.006065	1.65	47.7%	-0.98
D_{YEAR}	65	14	0.0419	-0.032004	**-6.41**	21.5%	**-4.79**	36	18	0.0222	0.006672	1.35	50.0%	-0.24
$D_{TOP20VOLUME}$	2,900	1,541	0.0131	0.001050	-0.95	53.1%	**2.02**	2,583	1,368	0.0106	0.001088	**-2.80**	53.0%	0.98
$D_{TOP30DAYS}$	960	507	0.0253	0.001914	0.77	52.8%	0.96	452	256	0.0261	0.002761	0.89	56.6%	1.97
D_{NYSE}	872	493	0.0122	0.001137	-0.35	56.5%	**3.12**	945	523	0.0095	0.001010	**-2.15**	55.3%	**2.06**
None of the above	3,777	1,876	0.0273	0.001447	0.37	49.7%	-1.96	3,264	1,655	0.0264	0.001912	0.51	50.7%	-1.48
All returns				0.001281		51.3%					0.001675		52.0%	
Pane D: 17:55-18:00														
D_{MONTH}	327	174	0.0268	0.002498	0.13	53.2%	-0.20	290	150	0.0249	0.002936	0.31	51.7%	-0.76
$D_{QUARTER}$	160	94	0.0289	0.003875	0.69	58.8%	1.26	96	47	0.0323	0.005463	0.90	49.0%	-0.98
D_{YEAR}	28	9	0.0479	-0.017111	**-2.14**	32.1%	**-2.30**	25	15	0.0221	0.008180	1.29	60.0%	0.61
$D_{TOP20VOLUME}$	2,475	1,340	0.0109	0.001002	**-5.94**	54.1%	0.37	1,862	1,011	0.0097	0.001259	**-5.44**	54.3%	0.31
$D_{TOP30DAYS}$	689	362	0.0241	0.003141	0.91	52.5%	-0.65	272	169	0.0277	0.006088	**2.14**	62.1%	**2.71**
D_{NYSE}	770	415	0.0108	0.001036	**-3.26**	53.9%	0.07	703	404	0.0081	0.001157	**-4.36**	57.5%	1.87
None of the above	2,212	1,163	0.0263	0.002933	1.12	52.6%	-1.13	1,823	966	0.0269	0.003228	1.18	53.0%	-0.82
All returns				0.002487		53.9%					0.002304		53.8%	
Pane E: 17:59-18:00														
D_{MONTH}	208	121	0.0243	0.003688	0.54	58.2%	0.46	191	100	0.0252	0.002686	-0.12	52.4%	-1.61
$D_{QUARTER}$	90	60	0.0266	0.007060	1.53	66.7%	1.93	67	33	0.0356	0.004945	0.47	49.3%	-1.47
D_{YEAR}	5	3	0.0781	-0.029285	-0.92	60.0%	0.15	16	10	0.0163	0.005729	0.69	62.5%	0.36
$D_{TOP20VOLUME}$	1,701	945	0.0096	0.000820	**-8.46**	55.6%	-0.85	1,339	765	0.0087	0.001344	**-6.58**	57.1%	-0.71
$D_{TOP30DAYS}$	404	209	0.0210	0.003452	0.64	51.7%	-1.96	153	95	0.0148	0.002995	0.07	62.1%	1.00
D_{NYSE}	632	382	0.0080	0.001458	**-4.15**	60.4%	1.96	612	369	0.0065	0.001309	**-6.14**	60.3%	1.10
None of the above	1,028	588	0.0274	0.004397	**1.90**	57.2%	0.40	892	527	0.0247	0.005146	**2.70**	59.1%	0.60
All returns				0.002779		56.6%					0.002910		58.1%	

The intercept of GRM stands for normal day-end return. The intercept return is positive for both sub-samples when the trading period before the close is 30 minutes or shorter. Note also that intercept returns are mainly insignificant and modest compared to dummy variable returns. On the other hand, the regression results of Table 9 show that the intercept is significant at 99% level of confidence in the last 15 minutes. This is consistent with the previous research, which reports positive returns near the close [Harris (1989)] and positive returns are not visible in longer intervals [Cushing and Madhavan (2000)].

Volume considerations

Volume-related explanations for high day-end returns are investigated with two basic dummy variables. $D_{TOP20VOLUME}$ variable investigates whether 20 high volume stocks explain the returns and $D_{TOP30DAYS}$ controls for 30 most active trading days in terms of trading volume. The return statistics of these variables show that volume does not explain high day-end returns. Top volume stocks get even significantly lower returns than the average return of the comparable period.

It should be noted that these two returns are insignificant because of the selection of the assumed mean (μ_0) in t-test and assumed proportion of positive returns (p_0) in Z-test. Since the investigated periods are short, it would also be justified to set μ_0 to zero and p_0 to 50.0%. The Appendix C shows GRM return statistics calculated with these values. Now the situation changes as volume appears to explain a part of the positive returns. When the evaluated period is 15 minutes before the close or less, the two returns are right-signed and significant at the 95% level of confidence. In Table 8, the corresponding values were the averages of the comparable periods.

However, as Table 8 already implied, regression results in relation to trading volume measures are weak. $D_{TOP20VOLUME}$ coefficients are only slightly positive in period 17:00-18:00 and 17:30-18:00. When the interval is shorter, the coefficients are negative and significant at the 99% level of the confidence five minutes before the close. Therefore, top volume stocks do not seem to explain the day-end returns.

Coefficients of $D_{TOP30DAYS}$ are insignificant in almost every period (only 17:55-18:00 period in After-sample gets significant return statistics and regression results). If top volume trading days had been excluded from the model, the results would not have changed drastically. In addition, high day-end returns are not explained by high volume days either. Similarly to the top volume stocks, high volume days' day-end returns are actually lower than the average returns. Therefore, as high day-end returns seem to be related more to stocks that trade infrequently, the results are consistent with Hillion and Suominen (2001). As Fig. 2 shows, only 13.3% (27 stocks) of all stocks trade over 100 times per day. In fact, low volume stocks could be more easily manipulated since the manipulator has greater probability of success. As trading volume does not appear to explain high day-end returns, the Hypothesis 2 is accepted.

Effect of the market closure

According to Harris (1989), day-end returns of a closing exchange should not be abnormal, if trading is able to continue in some other exchange after the first exchange closes. The Finnish NYSE stocks are traded relative actively at HEX, although the volumes at NYSE are quite low (except for Nokia and Sonera). This can imply that although the brokers and investors are, in theory, able to continue trading at NYSE, the trading opportunities can be disrupted in practise. However, since the largest brokers conduct a significant part of all trades at HEX and the majority of these brokers operate internationally; the data is suitable for the investigation of the market closure effect.

Table 9 Results of GRM

Day-end returns are regressed against a set of dummy variables. Each column represents different examined time interval (e.g. 17:00 stands for the period of 17:00-18:00)
The intercept stands for a normal return in the given period. D_{MONTH}, $D_{QUARTER}$ and D_{YEAR} take the value of one on the last day of the month, quarter or year. $D_{TOP20VOLUME}$ represent the 20 most active stocks and $D_{TOP30VOL}$ marks the 30 highest volume days. D_{NYSE} takes the value of one, when a stock is traded at both HEX and NYSE. Significance levels above 90% level of confidence are marked with bold.
Before-sample represents the period before the change in the evening trading rules on April 11, 2001 (August 3, 2000 – April 9, 2001) and After-sample represents the period after the change (April 11, 2001 – December 28, 2001).

	BEFORE					AFTER				
	17:00	17:30	17:45	17:55	17:59	17:00	17:30	17:45	17:55	17:59
Intercept	-0.0002	0.0008	0.0015	0.0033	0.0051	-0.0003	0.0015	0.0019	0.0032	0.0049
	-(0.66)	**(2.27)**	**(4.16)**	**(7.81)**	**(8.83)**	-(1.01)	**(4.17)**	**(5.19)**	**(6.78)**	**(8.67)**
D_{MONTH}	-0.0015	-0.0013	0.0002	-0.0010	-0.0016	0.0027	-0.0001	-0.0002	-0.0006	-0.0016
	-(1.04)	-(0.88)	(0.12)	-(0.63)	-(0.84)	(1.88)	-(0.05)	-(0.16)	-(0.39)	-(0.96)
$D_{QUARTER}$	0.0100	0.0085	0.0060	0.0062	0.0071	0.0043	0.0026	0.0045	0.0028	0.0030
	(4.30)	**(3.65)**	**(2.57)**	**(2.49)**	**(2.53)**	(1.53)	(0.96)	(1.74)	(0.94)	(1.00)
D_{YEAR}	-0.0103	-0.0112	-0.0396	-0.0220	-0.0325	-0.0003	0.0026	0.0009	0.0037	0.0011
	-(3.34)	**-(3.64)**	**-(11.65)**	**-(4.97)**	**-(3.58)**	-(0.08)	(0.64)	(0.21)	(0.75)	(0.21)
$D_{TOP20VOLUME}$	0.0008	0.0001	-0.0005	-0.0024	-0.0047	0.0009	-0.0004	-0.0009	-0.0021	-0.0033
	(1.32)	(0.14)	-(0.85)	**-(3.85)**	**-(5.89)**	(1.40)	-(0.60)	-(1.45)	**-(2.83)**	**-(4.05)**
$D_{TOP30DAYS}$	-0.0007	-0.0003	0.0006	0.0009	0.0008	-0.0001	-0.0001	0.0012	0.0038	-0.0001
	-(0.86)	-(0.39)	(0.68)	(1.04)	(0.79)	-(0.06)	-(0.07)	(1.16)	**(2.86)**	-(0.04)
D_{NYSE}	0.0002	-0.0003	0.0001	-0.0001	0.0008	0.0008	0.0002	-0.0003	-0.0005	-0.0005
	(0.19)	-(0.28)	(0.07)	-(0.12)	(0.84)	(0.80)	(0.21)	-(0.31)	-(0.53)	-(0.57)
F-value	**4.434**	**3.283**	**24.325**	**7.386**	**9.319**	**3.191**	0.641	1.690	**3.756**	**4.133**
R^2	0.047	0.046	0.138	0.091	0.135	0.046	0.023	0.040	0.074	0.100
N	11,956	9,345	7,509	5,296	3,027	9,041	7,372	6,455	4,075	2,434

The day-end returns of NYSE stocks are positive, but smaller than average return of the comparable periods. As the Appendix C shows, if μ_0 was equal to 0.000, the returns would be significant at the 99% level of confidence in eight cases of ten. According to regression results, coefficients of D_{NYSE} are negative in two out of five times in Before-sample and three out of five times in After-sample. In addition, coefficients are statistically insignificant in all the cases. These inconsistent and weak results imply that NYSE stocks are not different from other stocks near the close although the trading of those stocks is able to continue after HEX closes and consequently, Hypothesis 3 is accepted.

Seasonalities

Month-end returns are mainly weak regardless of the choice of μ_0 and p_0. Secondly, coefficients of D_{MONTH} are not in line with the hypotheses. The variable was designed to capture the cases in which, for instance, equity fund managers, large investors or corporations would drive up their investments' value around the month-end to show better monthly performance. Surprisingly, the coefficient is negative and the level of confidence is well below 90%.

Manipulation around month-ends can be categorised as short-sighted behaviour. For instance, if an equity fund manager manipulates closing prices to enhance fund performance at some point, she could be forced to manipulate repeatedly to show continuous good performance. In addition, given that equity funds in a certain sector tend to have quite similar portfolios, other equity funds could free ride at the expense of the manipulator. Therefore, the costs and disadvantages in the end can easily outweigh the benefits in the short run. In this sense, weak D_{MONTH} results are not so surprising after all.

Previous research on seasonalities [e.g. Agrawal and Tandon (1994) and Harris (1989)] has documented positive month-end returns. It seems that the positive turn-of-the-month returns usually accrue over a longer period than during the last trading hour. On the other hand, equity investors can deem CPM unattractive around month-ends since the earnings are reported quarterly and stock values influence taxation only at year-ends.

Equity investors normally use brokerage firms to handle orders on their behalf. These investors can place orders just before the close, but their execution ability is smaller compared to that of brokers. Therefore, chances of successful CPM are lower because manipulators cannot be certain whether their orders will be matched (although online dealing has recently improved the trading capabilities). If a manipulator wanted to be certain that she is able to move the prices she could trade well before the close. In fact, the return statistics in Table 9 show that quarter-ends are statistically significant and positive in the last hour, but insignificant in shorter periods. Similarly to the month-ends, the significance of quarter-end returns is not conditional to the choice of μ_0 and p_0.

The coefficients of $D_{QUARTER}$ are positive and significant at the 90-95% level of confidence in Before-sample. Note that coefficients are right-signed, but weak in After-sample. These findings suggest that closing prices can be manipulated to show better performance in quarterly earnings reports or other quarterly performance measures. However, it should be noted that the number of observations is relatively modest.

D_{YEAR}, which takes the value of one on the last trading day of the year, was designed to capture the year-end effect on day-end returns. The results are quite different in the two samples. Coefficients in Before-sample are negative and significant at the 99% level of confidence, but the coefficients are insignificant and positive (expect in 17:00-18:00 period) in After-sample. Note that the data includes only two year-ends and that the years 2000-2001 were relatively different in terms of annual returns. Note also that the number of observations in the shortest time intervals is insufficient to make decisive conclusions.

As the world markets including HEX were bullish during the first half of year 2000 (the market started to decline towards the year-end), the negative year-end returns in Before-sample are interesting. Investors tend to engage in wash sales near the year-end to lower capital gain taxes [see, e.g., Keloharju and Grinblatt (2004)]. If an investor has left her sell orders near the year-end, she can be forced to realise her positions at low stock prices just before the market closes. These late orders can cause a temporary fall in price levels.

The year 2001 was bearish as the HEX main index declined from almost 12,500 to 8,500 points. At the same time, coefficients of D_{YEAR} were positive although insignificant.

Therefore, it is unlikely that investors, at large, would have had the need to conduct wash sales. Consequently, there should not have been major pressure for a downward stock price movement near the year-end. This could explain the slightly positive and insignificant results of a bearish year. Note that if D_{YEAR} were omitted from the model, coefficients of $D_{QUARTER}$ would be positive and significant above the 90% level of confidence in both sub-samples.

In the end, the results imply that there can be a possible trading window relating to accounting data around quarter-ends, but not around month- and year-ends. If the Hypothesis 4 was to be rejected, the results should have been more consistent. Therefore, Hypothesis 4 is accepted.

7.3 Broker regression model

BRM is designed to capture cases in which brokers manipulate closing prices to influence, for instance, clients' interpretation of their execution ability. The manipulation should be visible in stock prices in two different ways; there should be a manipulation effect before the close and a reversal effect in the evening trading. BRM dummy variables investigate whether the manipulation effect is generated by brokers who have acquired (disposed) a large net position in a given stock during the day and pushed the closing price upwards (downwards) by purchasing (selling) the stock in the last 15 minutes of trading.

The variable definitions stay the same when the reversal effect is analysed. However, the model should get the opposite results. The opposite evening trading results would represent the stock prices returning to their true values. It should be noted that the manipulators are not required to make trades in the evening trading.

The period of 17:45-18:00 used in the dummy variable definitions and day-end return intervals is consistent with Felixson and Pelli (1999). Note that the explanatory power of GRM was highest 15 minutes or less before the close. If shorter time intervals had been used, the Study would have concentrated on high-volume stocks, which dominate the sample just before the close.

It should be noted that evening trading returns (18:30-18:18) in Before-sample do not necessarily represent the true stock values of their recorded trade time. Similarly to the data used in Felixson and Pelli (1999), trades reported in evening trading could have been arranged already during the day. In After-sample, the same problem is no longer present since the trading is conducted on continuous basis.

The results are presented as follows. First, the results before the close are presented. These results include return statistics, regression results and BRM extension results. Secondly, the findings after the close are presented in the same manner. Finally, the possible influences of the new evening trading opportunities are discussed.

Results before the official close

BRM return statistics and regression results of Model II are shown in Table 10 and Table 11, respectively. Since Model II received mainly insignificant results due to different kinds of variable definitions, the return statistics were calculated only for Model I. Regression results of Model II and BRM extension are presented in the Appendix E and Appendix F, respectively.

The intercept of BRM stands for the normal day-end return (17:45-18:00) when big buyers or sellers of the day have not been active 15 minutes before the close or there have not been any big buyers or sellers during the day at all. The intercept return is not different from the average return of the last 15 minutes. On the contrary, B_{ALL} and S_{ALL} variables are able to explain much of the day-end returns. In After-sample, B_{ALL} return is higher than the intercept return and significant at the 95% level of confidence in five cases of six in After-sample. In addition, sell side manipulation (S_{ALL}) has a negative impact on the day-end returns. This negative effect is present more in Before-sample although the middle-size net positions in After-sample get also negative returns at the 90% level of confidence. D_{BOTH} return is tilted towards zero just as it was predicted. Therefore, the return statistics show that there appears to be a constant manipulation effect near the close on both the buy and sell side.

It should be noted that the selections of the assumed mean (μ_0) in t-test and assumed proportion of positive returns (p_0) in Z-test have influence over the statistical significance of the results. If these test-measures had been calculated by setting μ_0=0.000 and p_0=50.0%, the intercept and B_{ALL} would be significant at the 95% level of confidence. On the other hand, S_{ALL} returns would be very weak as the Appendix D shows. T- and Z-statistics of Table 10 were calculated by using comparable periods' average return and proportion of positive returns.

Regression results are in line with the return statistics. BRM model seems to work; F-values of Model I are significant at the 99% level of confidence for the majority of net position sizes. Furthermore, the model is able to relate CPM to both sell and buy side manipulation. If the

Table 10 Return statistics of BRM before the close – Model I

The intercept stands for the normal day-end return (17:45-18:00) when big buyers or sellers of the day have not been active 15 minutes before the close or there have not been any big buyers or sellers during the day at all. B_{ALL} is the return of the last 15 minutes when a broker has acquired a big net position in one stock during the day, and acts as the buying broker near the close in the last trade of the day. S_{ALL} is the return of the last 15 minutes when a broker has disposed a big net position in one stock during the day, and acts as the selling broker near the close in the last trade of the day. D_{BOTH} is the return of the last 15 minutes when both big buyer and seller in one stock make the last trade. Note, that due to the dummy variable definitions, every observed return is categorised either as an intercept return or as one of the three dummy variables' return.

μ is the average return and σ is the standard deviation of the returns. T-statistics are compared to Student's t-distribution with n-1 degrees of freedom. Z-statistics are calculated to test whether the proportion of positive returns differs statistically from negative returns. The proportion is defined as positive returns / (positive + negative returns). μ_0 is the assumed mean and P_0 is the assumed proportion of positive returns near the close. μ_0 and P_0 are presented on the "All returns" row. Significance levels above 90% level of confidence are marked with bold.

Before-sample represents the period before the change in the evening trading rules on April 11, 2001 (August 3, 2000 – April 9, 2001) and After-sample represents the period after the change (April 11, 2001 – December 28, 2001).

	BEFORE						AFTER					
	Count	σ	μ	t-statistic	Positive %	z-statistic	Count	σ	μ	t-statistic	Positive %	z-statistic
All returns		0.0135	0.00124		52.5%			0.0130	0.00084		52.2%	
Panel A. Net position 20,000 €												
Intercept	1190	0.0151	0.00126	0.03	51.1%	-1.10	790	0.0157	0.00049	-0.63	50.8%	-1.31
B_{ALL}	618	0.0142	0.00287	**2.85**	54.5%	1.65	678	0.0123	0.00244	**3.39**	56.0%	**3.39**
S_{ALL}	496	0.0133	-0.00073	**-3.32**	49.6%	**-2.30**	715	0.0133	-0.00012	-1.93	51.7%	-0.43
D_{BOTH}	1054	0.0110	0.00120	-0.12	54.2%	1.36	1945	0.0118	0.00078	-0.23	51.7%	-0.50
Panel B. Net position 100,000 €												
Intercept	1260	0.0156	0.00152	0.63	51.6%	-0.71	1784	0.0150	0.00082	-0.08	51.8%	-0.34
B_{ALL}	553	0.0135	0.00238	1.99	54.2%	1.42	611	0.0115	0.00212	**2.74**	55.2%	**2.60**
S_{ALL}	498	0.0128	-0.00054	**-3.11**	49.2%	**-2.62**	693	0.0121	-0.00041	**-2.73**	49.4%	**-2.56**
D_{BOTH}	1047	0.0110	0.00115	-0.27	54.2%	1.35	1040	0.0102	0.00098	0.44	53.2%	0.84
Panel C. Net position 150,000 €												
Intercept	1504	0.0154	0.00146	0.55	51.8%	-0.78	2106	0.0148	0.00087	0.08	52.0%	-0.17
B_{ALL}	499	0.0133	0.00217	1.56	53.1%	0.74	557	0.0107	0.00216	**2.91**	56.7%	**4.00**
S_{ALL}	491	0.0118	-0.00060	**-3.46**	49.9%	**-2.99**	636	0.0116	-0.00022	**-2.30**	51.9%	-0.30
D_{BOTH}	864	0.0108	0.00136	0.33	54.7%	**2.64**	829	0.0102	0.00071	-0.38	49.9%	**-2.03**
Panel D. Net position 500,000 €												
Intercept	2284	0.0148	0.00141	0.53	52.3%	-0.16	3050	0.0141	0.00082	-0.10	51.8%	-0.38
B_{ALL}	340	0.0111	0.00180	0.93	53.8%	1.08	342	0.0100	0.00257	**3.19**	57.6%	**4.78**
S_{ALL}	334	0.0100	-0.00072	**-3.57**	48.8%	**-2.94**	377	0.0091	-0.00010	**-2.00**	52.3%	0.02
D_{BOTH}	400	0.0100	0.00146	0.44	55.5%	**2.42**	359	0.0080	0.00040	-1.04	50.7%	-1.36
Panel E. Net position 1,000,000 €												
Intercept	2666	0.0143	0.00121	-0.13	52.0%	-0.39	3427	0.0137	0.00077	-0.32	51.6%	-0.57
B_{ALL}	259	0.0095	0.00321	**3.33**	59.1%	**5.28**	249	0.0107	0.00221	**2.01**	55.8%	**3.20**
S_{ALL}	218	0.0097	-0.00114	**-3.61**	47.2%	**-4.18**	254	0.0088	0.00031	-0.97	55.1%	**2.57**
D_{BOTH}	215	0.0100	0.00174	0.72	55.8%	**2.67**	198	0.0065	0.00112	0.59	55.1%	**2.51**
Panel F. Net position 1,500,000 €												
Intercept	2866	0.0141	0.00121	-0.13	52.4%	-0.05	3598	0.0135	0.00080	-0.21	51.6%	-0.52
B_{ALL}	185	0.0095	0.00277	**2.18**	56.8%	**3.43**	209	0.0092	0.00110	0.40	55.0%	**2.49**
S_{ALL}	161	0.0087	-0.00111	**-3.44**	43.5%	**-7.19**	187	0.0086	0.00093	0.13	57.2%	**4.44**
D_{BOTH}	146	0.0096	0.00260	**1.71**	58.2%	**4.60**	134	0.0070	0.00162	1.29	56.7%	**3.99**

intercept had explained much of the results, day-end returns would be a result of general trading patterns or, unlikely, of a very systematic CPM.

The intercept is significant at the 90% level of confidence when the net position exceeds 100,000€. In addition, coefficients of the intercept are quite equally sized across different net position sizes. In this sense, the intercept captures the previously documented phenomenon that share prices tend to increase before the close [see, e.g., Hillion and Suominen (2001) and the GRM results of this Study].

Coefficients signs of B_{ALL} and S_{ALL} are in line with the hypotheses of this Study. It seems that brokers manipulate closing prices to show better intra-day trading performance or execution ability. However, it is surprising that the two sub-samples get quite different results. In Before-sample, coefficients of S_{ALL} are right-singed and significant at the 95% level of confidence while B_{ALL} results are mixed. The situation is almost the opposite in After-sample The CPM evidence on the sell side is interesting since CPM is normally considered to explain the high day-end returns. For instance, Hillion and Suominen (2001) model considers CPM on the buy side. On the other hand, Before-sample results are consistent with Kücükkocaoglu (2002), which reports CPM on the sell side when the overall market was under-performing. Note that there was a declining trend at HEX during the sample period.

Table 11 Results of BRM before the close – Model I

The intercept stands for the normal day-end return (17:45-18:00) when big buyers or sellers of the day have not been active 15 minutes before the close or there have not been any big buyers or sellers during the day at all. B_{ALL} variable takes the value of one when a broker has acquired a big net position in one stock during the day, and acts as the buying broker near the close in the last trade of the day. S_{ALL} variable takes the value of one when a broker has disposed a big net position in one stock during the day, and acts as the selling broker near the close in the last trade of the day. D_{BOTH} variable takes the value of one when both big buyer and seller make the last trade. Each column represents different net position sizes that were used to define whether a broker was a big buyer or seller. Significance levels above 90% level of confidence are marked with bold. Before-sample represents the period before the change in the evening trading rules on April 11, 2001 (August 3, 2000 – April 9, 2001) and After-sample represents the period after the change (April 11, 2001 – December 28, 2001).

	BEFORE						AFTER					
	20,000€	100,000€	150,000€	500,000€	1,000,000€	1,500,000€	20,000€	100,000€	150,000€	500,000€	1,000,000€	1,500,000€
Intercept	0.0013	0.0015	0.0015	0.0014	0.0012	0.0012	0.0005	0.0008	0.0009	0.0008	0.0008	0.0008
	(3.21)	**(3.99)**	**(4.19)**	**(4.97)**	**(4.61)**	**(4.78)**	(1.06)	**(2.66)**	**(3.08)**	**(3.49)**	**(3.47)**	**(3.68)**
B_{ALL}	0.0016	0.0009	0.0007	0.0004	0.0020	0.0016	0.0020	0.0013	0.0013	0.0017	0.0014	0.0003
	(2.41)	(1.25)	(1.02)	(0.50)	**(2.27)**	(1.52)	**(2.88)**	**(2.14)**	**(2.09)**	**(2.36)**	(1.69)	(0.33)
S_{ALL}	-0.0020	-0.0021	-0.0021	-0.0021	-0.0023	-0.0023	-0.0006	-0.0012	-0.0011	-0.0009	-0.0005	0.0001
	-(2.75)	**-(2.88)**	**-(2.93)**	**-(2.68)**	**-(2.46)**	**-(2.12)**	-(0.91)	**-(2.12)**	-(1.86)	-(1.29)	-(0.54)	(0.13)
D_{BOTH}	-0.0001	-0.0004	-0.0001	0.0001	0.0005	0.0014	0.0003	0.0002	-0.0002	-0.0004	0.0003	0.0008
	-(0.10)	-(0.65)	-(0.17)	(0.07)	(0.55)	(1.21)	(0.53)	(0.33)	-(0.31)	-(0.57)	(0.37)	(0.72)
F-value	**6.526**	**4.390**	**3.970**	**2.684**	**4.178**	**2.907**	**4.951**	**4.178**	**3.371**	**2.808**	1.124	0.205
R^2	0.076	0.063	0.059	0.049	0.061	0.051	0.060	0.055	0.049	0.045	0.029	0.012
N	3,354	3,354	3,354	3,354	3,354	3,354	4,124	4,124	4,124	4,124	4,124	4,124

The power of Model II is clearly poorer compared to Model I; F-values of Model II are significant only with three position sizes. The lower explanatory power is probably caused by different variable definitions. In Model I, B_{ALL} or S_{ALL} take the value of one when the expected manipulative broker has made the last trade of the day. Model II requires also that the manipulator is active in the last 15 minutes, but the variable takes the value of manipulator's buys or sells divided by all trades in the given stock. In addition, it is not required that the broker makes the last trade. It is apparent that B_{ALL} is more affected by the variable definition than S_{ALL}.

As explained in the variable definitions, D_{BOTH} captures cases in which manipulation is expected to have occurred both on the buy and sell side. Since the variable includes two opposite price movements, D_{BOTH} coefficients are close to zero and the level of confidence never reaches even the 90% level. If D_{BOTH} dummies had explained the overall results more than the other dummy variables, the model would have failed to identify whether the CPM has occurred on the buying or sell side. In this sense, insignificant D_{BOTH} coefficients are not problematic from the perspective of the CPM hypothesis.

BRM extension results are insignificant results for the majority of broker-specific dummies. However, coefficient of B_{ALF} and S_{ALF} are right-signed and significant at the level 95% confidence when the net position size in Before-sample is between 20,000€ and 150,000€. There is evidence of CPM also in After-sample (S_{EVL} with net positions of 20,000€ and 150,000€). Therefore, the results imply that the manipulation effect can be related to specific brokers. In fact, it is unlikely that all brokers would be involved in CPM. A large-scale manipulation would not surely go unnoticed by stock exchange officials.

In conclusion, the power of Model I is satisfactory for the lower net positions (20,000-500,000€). Felixson and Pelli (1999) suggest that higher net position could be taken due to external reasons (e.g. earnings announcement or merger speculation Therefore, weak results for the highest position values may not be to harmful from the perspective of the CPM theory. Secondly, BRM gets stronger results when the dummy variable definitions of Model I are used. Thirdly, BRM is able to identify the side of the occurred manipulation, as sell side manipulation appears to be stronger in Before-sample and buy side in After-sample. Fourthly, BRM extension results show that individual brokers can be responsible for the unusual day-end return patterns. Therefore, brokers can manipulate closing prices when they have acquired or sold a large net position earlier in the day. Moreover, day-end returns compound the manipulation and Hypothesis 5 is rejected.

Results after the close

BRM return statistics and regression results of Model I are shown in Table 12 and Table 13, respectively. Return statistics are calculated for Model I. Regression results of Model II and BRM extension are presented in the Appendix H and Appendix I respectively. Return statistics of Table 12 show that the number of observations is smaller in the evening trading compared to end-of-the-day period. Nevertheless, evening trading volume is still sufficient to test the reversal effect. On the other hand, if only those day and stock combinations that have observations before and after the close were included, the results before the close would not have changed drastically.

After the close, the intercept of BRM is defined as the normal return of the first 15 evening trading minutes (18:03-18:18) when big buyers or sellers have not been active near the close (17:45-18:00) or there have been not been any big buyers or sellers during the day at all.

In After-sample, B_{ALL} returns are negative and significant above the 90% level of confidence in five cases of six. In addition, D_{BOTH} returns are mainly negative in both sub-samples although not statistically significant.. The evidence on S_{ALL} is mixed and the highest net positions get negative returns in both sub-samples. Therefore, the reversal effect is stronger on the buy side As the Appendix G shows, the statistical significance of the return statistics is not dependent on the choice of μ_0 and p_0, like it was with the case before the close.

Regression results are encouraging especially in After-sample; F-values of Model I range from 2.288 to 4.447 when the net position size is above 100,000€. Corresponding F-values of Model II are actually higher, but much of its explanatory power is related to D_{BOTH}. Therefore, Model I is better in identifying the manipulation source. Weak results before the change in the evening trading rules are not alarming due to the noisy returns. Therefore, as the new evening trading prices reflect better the true stock values, the explanatory power of BRM increases.

Table 12 Return statistics of BRM after the close – Model I

The intercept stands for a normal return of the first 15 evening trading minutes (18:03-18:18) when big buyers or sellers have not been active near the close (17:45-18:00) or there have not been any big buyers or sellers during the day at all. B_{ALL} is the return of the first 15 evening trading minutes when a broker has acquired a big net position in one stock during the day, and acts as the buying broker near the close in the last trade of the day. S_{ALL} is the return of the first 15 evening trading minutes when a broker has disposed a big net position in one stock during the day, and acts as the selling broker near the close in the last trade of the day. D_{BOTH} is the return of the first 15 evening trading minutes when both big buyer and seller in one stock make the last trade. Note, that due to the dummy variable definitions, every return is categorised either as an intercept return or as one of the three dummy variables' return.

μ is the average return and σ is the standard deviation of the returns. T-statistics are compared to Student's t-distribution with n-1 degrees of freedom. Z-statistics are calculated to test whether the proportion of positive returns differs statistically significantly from negative returns. The proportion is defined as positive returns / (positive + negative returns). μ_0 is the assumed mean and P_0 is the assumed proportion of positive returns of first 15 evening trading minutes. μ_0 and P_0 are presented on the "All returns" row. Significance levels above 90% level of confidence are marked with bold.

Before-sample represents the period before the change in the evening trading rules on April 11, 2001 (August 3, 2000 – April 9, 2001) and After-sample represents the period after the change (April 11, 2001 – December 28, 2001).

BEFORE

	Count	σ	μ	t-statistic	Positive %	z-statistic
All returns		0.0257	-0.00009		51.1%	
Panel A. Net position 20,000 €						
Intercept	438	0.0162	-0.00006	0.04	52.9%	1.13
B_{ALL}	538	0.0302	0.00002	0.08	48.9%	-1.37
S_{ALL}	391	0.0228	0.00094	0.89	54.9%	**2.32**
D_{BOTH}	1346	0.0246	-0.00041	-0.48	50.4%	-0.42
Panel B. Net position 100,000 €						
Intercept	939	0.0204	0.00006	0.21	51.9%	0.51
B_{ALL}	476	0.0305	-0.00163	-1.10	49.3%	-1.09
S_{ALL}	413	0.0259	0.00047	0.43	54.2%	1.92
D_{BOTH}	885	0.0237	0.00031	0.50	49.9%	-0.72
Panel C. Net position 150,000 €						
Intercept	1119	0.0214	0.00041	0.78	52.5%	0.89
B_{ALL}	434	0.0319	-0.00314	**-1.99**	48.0%	-1.92
S_{ALL}	418	0.0272	0.00099	0.81	53.9%	1.72
D_{BOTH}	742	0.0217	0.00014	0.28	49.6%	-0.89
Panel D. Net position 500,000 €						
Intercept	1739	0.0247	0.00037	0.77	52.2%	0.70
B_{ALL}	305	0.0264	-0.00368	**-2.38**	48.6%	-1.55
S_{ALL}	301	0.0256	0.00100	0.74	50.6%	-0.30
D_{BOTH}	368	0.0238	-0.00031	-0.18	49.4%	-1.06
Panel E. Net position 1,000,000 €						
Intercept	2067	0.0254	0.00029	0.67	52.3%	0.72
B_{ALL}	234	0.0232	-0.00293	-1.88	47.0%	**-2.51**
S_{ALL}	206	0.0282	-0.00101	-0.47	48.8%	-1.38
D_{BOTH}	206	0.0219	0.00015	0.16	48.9%	-1.37
Panel F. Net position 1,500,000 €						
Intercept	2244	0.0255	0.00015	0.44	52.0%	0.55
B_{ALL}	170	0.0241	-0.00126	-0.63	50.7%	-0.26
S_{ALL}	154	0.0277	-0.00212	-0.91	46.7%	**-2.71**
D_{BOTH}	145	0.0219	-0.00027	-0.10	45.7%	**-3.32**

AFTER

	Count	σ	μ	t-statistic	Positive %	z-statistic
All returns		0.0117	0.00003		48.6%	
Panel A. Net position 20,000 €						
Intercept	271	0.0153	-0.00027	-0.33	52.0%	**2.00**
B_{ALL}	312	0.0092	0.00012	0.16	48.7%	0.05
S_{ALL}	299	0.0117	0.00020	0.24	46.5%	-1.26
D_{BOTH}	802	0.0111	0.00004	0.02	48.3%	-0.22
Panel B. Net position 100,000 €						
Intercept	538	0.0141	0.00079	1.24	52.2%	**2.12**
B_{ALL}	288	0.0121	-0.00153	**-2.19**	44.4%	**-2.47**
S_{ALL}	313	0.0107	0.00135	**2.17**	49.8%	0.71
D_{BOTH}	545	0.0089	-0.00065	-1.80	46.4%	-1.30
Panel C. Net position 150,000 €						
Intercept	644	0.0142	0.00061	1.03	52.5%	**2.27**
B_{ALL}	275	0.0087	-0.00109	**-2.13**	45.5%	-1.87
S_{ALL}	307	0.0105	0.00082	1.32	48.5%	-0.06
D_{BOTH}	458	0.0098	-0.00065	-1.48	45.2%	-2.02
Panel D. Net position 500,000 €						
Intercept	981	0.0135	0.00055	1.20	51.9%	1.91
B_{ALL}	224	0.0092	-0.00191	**-3.17**	42.4%	**-3.66**
S_{ALL}	227	0.0087	0.00048	0.76	47.1%	-0.88
D_{BOTH}	252	0.0076	-0.00065	-1.42	42.9%	**-3.40**
Panel E. Net position 1,000,000 €						
Intercept	1162	0.0130	0.00057	1.42	51.6%	1.77
B_{ALL}	189	0.0086	-0.00174	**-2.82**	42.3%	**-3.71**
S_{ALL}	187	0.0079	-0.00104	-1.87	39.6%	**-5.33**
D_{BOTH}	146	0.0073	-0.00060	-1.05	44.5%	**-2.42**
Panel F. Net position 1,500,000 €						
Intercept	1269	0.0128	0.00044	1.15	50.7%	1.24
B_{ALL}	161	0.0073	-0.00117	**-2.08**	43.5%	**-3.03**
S_{ALL}	142	0.0071	-0.00171	**-2.90**	39.4%	**-5.41**
D_{BOTH}	112	0.0073	-0.00069	-1.04	43.8%	**-2.87**

Intercept coefficients are insignificant in Model I and significant at the 95% level of confidence in Model II only when the net position sizes are 1,000,000€ and 1,500,000€. Before the close, the intercept was significant at the 99% level of confidence with almost every net position size. However, weaker intercept results are not problematic from BRM perspective since the model should capture the reversal effect with its dummy variables.

Coefficients of B_{ALL} are distinctly larger than the intercepts and right-singed in four case of six in After-sample. Furthermore, B_{ALL} is significant at the 95% level of confidence with net positions between 100,000€ and 1,000,000€. Therefore, BRM seems to work well in capturing the reversal effect on the buy side after the evening trading rules changed. It is surprising though that S_{ALL} gets mixed results after the close while the results were consistent and right-signed when the manipulation effect was examined. D_{BOTH} return statistics and regression results are weak and inconsistent.

As BRM extension results for After-sample show, broker-specific investigation does not reveal new information about the reversal effect. If the amount of broker-specific observations had been higher, the results would likely have improved. Note that two coefficients of B_i (B_{ES} and B_{ALF}) are negative with the 95% level of confidence in Before-sample. However, since the evening trading returns are noisy in Before-sample, too much weight should not be put on these findings.

In conclusion, the power of Model I in After-sample is satisfactory in five cases of six. Furthermore, there is a clear negative reversal effect present implying that CPM has likely occurred on the buy side. Therefore, there is adequate evidence of the reversal effect on the buy side and consequently, Hypothesis 6 is rejected.

Table 13 Results of BRM after the close – Model I

The intercept stands for a normal return of the first 15 evening trading minutes (18:03-18:18) when big buyers or sellers have not been active near the close (17:45-18:00) or there have not been any big buyers or sellers during the day at all. B_{ALL} variable takes the value of one when a broker has acquired a big net position in one stock during the day, and acts as the buying broker near the close in the last trade of the day. S_{ALL} variable takes the value of one when a broker has disposed a big net position in one stock during the day, and acts as the selling broker near the close in the last trade of the day. D_{BOTH} variable takes the value of one when both big buyer and seller make the last trade. Each column represents different net position sizes that were used to define whether a broker was a big buyer or seller Significance levels above 90% level of confidence are marked with bold.
Before-sample represents the period before the change in the evening trading rules on April 11, 2001 (August 3, 2000 – April 9, 2001) and After-sample represents the period after the change (April 11, 2001 – December 28, 2001).

	BEFORE						AFTER					
	20,000€	100,000€	150,000€	500,000€	1,000,000€	1,500,000€	20,000€	100,000€	150,000€	500,000€	1,000,000€	1,500,000€
Intercept	-0.0001	0.0001	0.0005	0.0004	0.0003	0.0002	-0.0003	0.0008	0.0006	0.0005	0.0006	0.0004
	-(0.11)	(0.10)	(0.72)	(0.66)	(0.54)	(0.29)	-(0.38)	(1.57)	(1.33)	(1.47)	(1.67)	(1.35)
B_{ALL}	0.0002	-0.0017	-0.0037	-0.0041	-0.0032	-0.0014	0.0004	-0.0023	-0.0017	-0.0025	-0.0023	-0.0016
	(0.10)	-(1.18)	**-(2.55)**	**-(2.57)**	-(1.83)	-(0.69)	(0.40)	**-(2.72)**	**-(2.02)**	**-(2.85)**	**-(2.53)**	-(1.65)
S_{ALL}	0.0011	0.0004	0.0004	0.0006	-0.0013	-0.0023	0.0005	0.0006	0.0002	-0.0001	-0.0016	-0.0021
	(0.60)	(0.25)	(0.30)	(0.37)	-(0.70)	-(1.07)	(0.48)	(0.68)	(0.26)	-(0.08)	-(1.76)	**-(2.08)**
D_{BOTH}	-0.0003	0.0002	-0.0004	-0.0007	-0.0001	-0.0004	0.0003	-0.0014	-0.0013	-0.0012	-0.0012	-0.0011
	-(0.19)	(0.19)	-(0.34)	-(0.49)	-(0.08)	-(0.19)	(0.38)	**-(2.04)**	-(1.76)	-(1.45)	-(1.14)	-(0.98)
F-value	0.280	0.721	**2.550**	**2.407**	1.212	0.510	0.086	**4.447**	**2.359**	**3.107**	**2.955**	**2.288**
R^2	0.018	0.028	0.053	0.052	0.037	0.024	0.012	0.089	0.065	0.074	0.072	0.064
N	2,709	2,709	2,709	2,709	2,709	2,709	1,680	1,680	1,680	1,680	1,680	1,680

7.4 What are the implications of the change in the evening trading rules?

The beginning of the new continuous-based trading evening has not significantly changed day-end trading patterns. Day-end trading has slowed down, but not remarkably. Moreover, day-end returns are almost at the same level as before the change in the trading rules. The last trade returns are still positive at the 99% level of confidence and distinctly larger than returns of the preceding trades. From CPM perspective, these high closes in After-sample can be considered as a sign of continuing CPM.

The power of the GRM is clearly poorer in After-sample. The results show that $D_{QUARTER}$ and $D_{YEAR\text{-}END}$ coefficients are no longer statistically significant. GRM return statistics regarding After-sample show also that day-end returns are still high. Furthermore, returns of high volume stocks are actually higher in After-sample than in Before-sample. Consequently, the start of the new evening training has not had any major influence over trading at the close from CPM perspective. If traders wanted to avoid stock purchases at higher prices just before the close, they could have postponed their trades to evening trading.

It is important to notice that the investigation of the reversal effect has improved after evening trading rules changed. As the new evening trading prices reflect the true stock values of the time, BRM is able to capture the reversal effect. Model's explanatory power has increased and, in particular, buy side manipulation results in After-sample are significant at the 95% level of confidence in four cases of five. In this sense, the results are in line with the basic CPM hypothesis: manipulation is stronger on the buy side than on the sell side. Previous studies have failed in capturing the reversal effect either because previous evening trading returns have been noisy [Felixson and Pelli (1999)] or because next-day's opening returns have been used [Kücükkocaoglu (2002)]. However, it should be noted that BRM was not able to detect the reversal effect on the sell side in either of the sub-samples.

In conclusion, unaffected return patterns before the close and stronger BRM results after the close in After-sample imply that CPM is present at HEX and that it was not affected by the change in the evening trading rules. Only notable difference between the two sub-samples is that manipulation by brokers is stronger on the buy side in After-sample while sell side appeared to be stronger in Before-sample. Therefore, as the day-end returns are unaffected by the change in evening trading rules, hypothesis 7 is accepted.

8 Conclusions

After the evening trading rules changed at HEX, trading has been able to continue for three more hours with the same rules than in the primary trading. Since traders are able to stay at the market, they can postpone orders to evening trading. This way, traders can avoid trading in a period in which stock prices rise significantly. However, the results show that there are only slight changes in trader behaviour. Although trading volume dropped a little bit, the day-end returns are still high compared to the rest of the day. It seems that brokers are not willing to postpone their trades to evening trading and avoid high day-end prices. Traders' regular working hours cannot be the only reason to the eagerness to fill-up their order books before the close resulting in rapid return peaks while there is a relatively active evening trading available in matter of minutes.

GRM shows that top volume stocks or trading days do not explain the high day-end returns. If the high day-end returns near the close were explained by volume reasons, it would be difficult to argue that closing prices are manipulated. Furthermore, continuing trading opportunities at NYSE after HEX closes do not have influence over the day-end returns of Finnish NYSE stocks. Therefore, it is more likely that high (or low) closes can be caused by CPM.

Quarter-ends explain part of the high closes. If corporate investors or equity fund managers preferred to boost up their quarterly performance, they could achieve this by CPM. It is not difficult to drive up the stock value just before the close at HEX and that the action goes unnoticed by authorities since high closes are more or less an every day trading pattern. Of course, this manipulation would have to be repeated on a continuous basis depending on the future market development.

Negative year-end returns are not surprising although they are not consistent with positive quarter-end returns. It should be noted that the amount of year-end observations was limited in this Study. As investors tend to engage in wash sales, there can be a lot of selling pressure on last trading days of the year. If large amounts of sell orders remained unmatched in broker's order books, brokers could be forced to sell low to meet their customers' orders for the year-end. Therefore, the year-end effect is likely more related to wash sales than CPM.

BRM results suggest that brokers can manipulate closing prices. Brokers who acquired a large net position during the day were also active 15 minutes before the close as the buying counterpart. At the same time, the day-end returns are positive. There is also evidence that big net position sellers participated in opposite behaviour. This kind of broker behaviour leads to a situation in which sells and buys of the day appear better executed given that broker performance is evaluated by using closing prices. It is self-evident that the use of closing prices in broker performance evaluation can encourage brokers to CPM. However, corporate investors may not have the time or capability to evaluate brokers' execution ability by more sophisticated means like intraday average transaction prices compared to the official closes.

Statistical significance of the BRM results varies when the net position size changes. BRM works quite adequately for the middle net positions before the close. The insignificant results of the lower net position sizes can be explained by low incentives to manipulate. If the acquired or disposed net position was small in absolute terms, a broker could deem manipulation as too risky for the marginal benefits. However, middle net positions get significant and consistent BRM results. It is possible that once the trading activity is high enough, the situation changes and brokers are more motivated to manipulate. On the other hand, weak results of the highest position values can be explained by the Felixson and Pelli (1999) assumption that high positions are taken for external reasons, which do not facilitate CPM. These external reasons can be such as earnings announcement or merger rumours.

There is evidence of the reversal effect i.e. stock prices return to the true values after manipulators have no longer intention to sustain a certain price level. The effect is noticeable on the buy side in After-sample. Therefore, it is very important to notice that BRM works adequately after the close only when evening trading is conducted on continuous based. In this sense, the evening trading rule change at HEX has made it possible to detect the reversal effect after the official day closing. Furthermore, since the new continuous-based evening trading has not altered the trading patterns before the close and, in particular, there still are high positive returns, CPM has likely continued at HEX regardless of the trading rules change.

8.1 Implication of results

The results of this Study suggest that CPM is present at HEX. In addition, the results are consistent with acknowledged results and models in previous empirical literature. Therefore, it is fair to assume that there are brokers or investors who are willing and able to manipulate the market in the closing period. Although the market frictions due to the manipulation are quite limited and the stock prices return to their true values shortly after the manipulation, exchanges should take closing price manipulation into consideration when determining their trading rules and most importantly, closing price mechanism.

If exchanges continue using the last observed price as the official closing price, manipulation would be easy. The major exchanges normally use different kinds of closing price mechanisms in which closing prices are determined as certain weighted-averages from trades in a specific time interval before the close. These kinds of closing price calculation methods should also be used at HEX.

8.2 Future research

A more sophisticated model for broker manipulation investigation would be in order. For instance, it would be worthwhile to model broker behaviour more in-depth than what was done in this Study. Future research should examine whether broker's trading behaviour changes before and after the suspected CPM. If the broker acquires (disposes) the net position well before the close and then suddenly pushes closing prices upwards (downwards) just before day-closing, it would be easier to verify that CPM has taken place. Moreover, if some broker has manipulated the closing prices, it would be interesting to know whether she trades the same stock also in the evening trading. If the manipulative trades were reversed after the close, the possibility of CPM would increase. On the other hand, cases in which brokers are continuously buying or selling some stocks over a longer period should be investigated with care. For instance, if brokers have acquired certain stocks over several days, the possible CPM can also happen only at the end of the purchasing period. Of course, any future model should investigate CPM at a broker-level.

Future research and exchange officials' interest should also concentrate on possible manipulation around quarter- and year-ends.

Appendix A – Intraday trading statistics around the close, Before-sample

μ is one trade average return. "μ < o", "μ = o", "μ > 0 ", indicate the proportion of trades that have negative, zero or positive returns, respectively. σ is the standard deviation of returns.

Before-sample represents the period before the change in the evening trading rules on April 11, 2001 (August 3, 2000 – April 9, 2001).

BEFORE

Period	Daily trades	Daily volume €	AVG lot size	AVG trade size €	μ <0	μ = 0	μ > 0	μ	σ
17:00-17:05	159.6	12,573,883	2,779.5	78,793.8	13.7%	73.3%	13.0%	-0.00004	0.00442
17:05-17:10	160.4	12,446,442	2,750.3	77,611.1	13.7%	73.2%	13.1%	-0.00010	0.00480
17:10-17:15	161.1	12,009,200	2,710.4	74,541.3	13.6%	73.2%	13.2%	-0.00008	0.00483
17:15-17:20	168.3	12,437,486	2,645.5	73,902.7	13.9%	72.7%	13.4%	-0.00004	0.00451
17:20-17:25	176.2	12,123,981	2,605.9	68,812.9	13.5%	73.2%	13.3%	-0.00002	0.00485
17:25-17:30	195.9	14,431,347	2,817.4	73,657.1	14.0%	72.0%	13.9%	0.00003	0.00494
17:30-17:35	156.1	13,208,667	3,265.0	84,618.5	14.3%	72.3%	13.4%	-0.00014	0.00786
17:35-17:40	157.9	12,311,519	2,903.0	77,960.3	14.3%	72.2%	13.5%	-0.00003	0.00704
17:40-17:45	170.6	13,371,343	2,958.5	78,366.8	13.8%	72.5%	13.7%	0.00003	0.00561
17:45-17:50	185.3	13,463,320	2,762.5	72,672.0	14.2%	72.0%	13.8%	-0.00003	0.00616
17:50-17:55	213.0	15,489,482	2,848.2	72,720.6	14.0%	72.0%	14.0%	0.00001	0.00525
17:55-17:56	48.8	3,339,416	2,736.2	68,381.3	14.3%	71.4%	14.3%	0.00005	0.00550
17:56-17:57	53.7	4,182,274	3,781.5	77,900.3	14.7%	70.8%	14.6%	0.00001	0.00577
17:57-17:58	60.7	4,231,107	2,694.5	69,732.6	15.1%	70.4%	14.6%	0.00012	0.00633
17:58-17:59	68.5	4,928,423	3,031.9	71,935.8	15.0%	69.9%	15.1%	0.00019	0.00610
17:59-18:00	121.8	9,572,060	3,134.4	78,598.6	15.1%	68.1%	16.8%	0.00040	0.00752
17:45-17:46	36.7	2,787,453	3,030.0	75,931.2	14.1%	72.2%	13.7%	-0.00005	0.00564
17:46-17:47	35.0	2,798,770	2,983.9	79,913.0	13.7%	72.5%	13.8%	-0.00004	0.00662
17:47-17:48	36.9	2,521,527	2,570.7	68,306.7	14.7%	71.4%	13.9%	-0.00003	0.00666
17:48-17:49	37.4	2,558,483	2,556.7	68,454.4	14.1%	72.6%	13.3%	-0.00004	0.00534
17:49-17:50	39.2	2,797,086	2,691.2	71,284.0	14.5%	71.5%	14.0%	-0.00001	0.00642
17:50-17:51	39.4	2,749,286	2,787.9	69,823.1	13.6%	72.4%	14.0%	-0.00002	0.00491
17:51-17:52	42.5	3,141,202	2,855.1	73,831.7	14.3%	71.7%	14.1%	0.00002	0.00583
17:52-17:53	40.8	3,051,909	2,847.1	74,778.8	14.1%	71.9%	14.0%	0.00001	0.00492
17:53-17:54	44.1	3,178,510	2,756.0	72,080.6	13.9%	72.2%	13.8%	0.00003	0.00498
17:54-17:55	46.2	3,368,575	2,982.2	72,959.5	14.0%	72.1%	13.9%	0.00002	0.00551
17:55-17:56	48.8	3,339,416	2,736.2	68,381.3	14.3%	71.4%	14.3%	0.00005	0.00550
17:56-17:57	53.7	4,182,274	3,781.5	77,900.3	14.7%	70.8%	14.6%	0.00001	0.00577
17:57-17:58	60.7	4,231,107	2,694.5	69,732.6	15.1%	70.4%	14.6%	0.00012	0.00633
17:58-17:59	68.5	4,928,423	3,031.9	71,935.8	15.0%	69.9%	15.1%	0.00019	0.00610
17:59-18:00	121.8	9,572,060	3,134.4	78,598.6	15.1%	68.1%	16.8%	0.00040	0.00752
18:00-18:01	22.5	12,594,607	21,130.4	560,609.7	1.9%	95.6%	2.5%	0.00021	0.00715
18:01-18:02	20.7	14,599,074	26,946.9	705,501.6	0.0%	100.0%	0.0%	0.00000	0.00000
18:02-18:03	17.7	11,931,757	26,626.5	673,937.5	0.0%	100.0%	0.0%	0.00000	0.00000
18:03-18:04	15.5	10,499,657	26,706.7	679,139.9	23.8%	54.0%	22.2%	-0.00088	0.03448
18:04-18:05	12.1	7,100,709	24,135.4	584,803.4	23.9%	54.2%	21.8%	-0.00094	0.04382
18:05-18:06	10.6	6,375,928	27,034.9	602,989.4	23.5%	54.0%	22.4%	-0.00011	0.04033
18:06-18:07	8.7	5,697,910	28,424.3	654,590.1	23.0%	54.4%	22.6%	-0.00093	0.03702
18:07-18:08	7.2	4,235,495	24,842.1	589,286.3	22.5%	54.9%	22.7%	-0.00171	0.04111
18:08-18:09	5.9	3,985,970	27,084.4	671,321.3	22.7%	54.7%	22.6%	-0.00011	0.03288
18:09-18:10	5.5	3,997,834	26,827.8	729,895.0	23.4%	54.6%	22.0%	-0.00114	0.03037
18:10-18:11	4.4	2,425,101	23,147.2	553,589.9	21.4%	54.6%	24.0%	0.00202	0.03047
18:11-18:12	3.9	2,636,858	26,693.2	681,478.7	24.4%	54.4%	21.2%	-0.00121	0.03195
18:12-18:13	3.3	2,377,139	27,674.6	715,173.5	21.3%	54.4%	24.3%	0.00068	0.03597
18:13-18:14	2.9	1,791,162	26,952.4	613,316.1	22.1%	55.2%	22.7%	-0.00013	0.03021
18:14-18:15	2.5	1,212,778	21,501.0	479,660.7	21.5%	55.0%	23.5%	-0.00032	0.03050
18:15-18:16	0.1	16,796	12,440.0	164,227.8	22.6%	58.1%	19.4%	-0.00399	0.03467
18:16-18:17	0.1	3,147	1,807.1	39,564.3	8.7%	60.9%	30.4%	0.00024	0.03219
18:17-18:18	0.0	1,338	1,935.8	29,437.5	25.0%	66.7%	8.3%	-0.00171	0.00320

Appendix A – Intraday trading statistics around the close, After-sample

μ is one trade average return. "μ < o", "μ = o", "μ > 0 ", indicate the proportion of trades that have negative, zero or positive returns, respectively. σ is the standard deviation of returns.
After-sample represents the period after the change in the evening trading rules on April 11, 2001 (April 11, 2001 – December 28, 2001).

AFTER

Period	Daily trades	Daily volume €	AVG lot size	AVG trade size €	μ <0	μ = 0	μ > 0	μ	σ
17:00-17:05	160.3	12,419,049	3,949.9	77,473.2	13.8%	72.6%	13.7%	-0.00006	0.00427
17:05-17:10	148.8	11,124,116	3,845.3	74,746.9	13.3%	73.8%	12.9%	-0.00005	0.00483
17:10-17:15	143.8	11,215,031	4,067.7	77,986.8	13.5%	73.1%	13.4%	-0.00004	0.00411
17:15-17:20	139.6	9,980,838	3,896.9	71,471.5	13.6%	73.6%	12.9%	-0.00005	0.00443
17:20-17:25	136.7	8,971,978	3,514.1	65,622.2	13.7%	73.4%	12.9%	-0.00007	0.00451
17:25-17:30	139.6	9,506,159	3,751.5	68,083.5	13.4%	73.2%	13.4%	-0.00004	0.00513
17:30-17:35	139.8	9,462,774	3,700.2	67,679.1	13.7%	73.3%	13.0%	-0.00005	0.00452
17:35-17:40	145.1	9,785,261	3,675.3	67,437.0	13.4%	73.2%	13.4%	0.00002	0.00533
17:40-17:45	156.6	10,840,571	3,829.2	69,233.6	13.2%	73.5%	13.3%	-0.00002	0.00470
17:45-17:50	165.5	10,938,730	3,763.3	66,086.0	13.4%	73.3%	13.3%	0.00003	0.00471
17:50-17:55	181.6	12,129,799	3,843.6	66,776.5	13.7%	72.7%	13.5%	0.00001	0.00504
17:55-17:56	41.9	2,774,674	3,807.4	66,233.9	13.1%	72.7%	14.2%	0.00011	0.00644
17:56-17:57	43.0	2,656,768	3,670.3	61,809.8	13.9%	72.4%	13.7%	0.00002	0.00532
17:57-17:58	44.1	2,905,867	3,743.1	65,880.8	13.8%	72.0%	14.3%	0.00019	0.00607
17:58-17:59	52.2	3,665,986	4,131.2	70,208.2	14.0%	72.0%	14.1%	0.00010	0.00609
17:59-18:00	110.0	7,856,803	4,141.1	71,403.4	15.2%	67.4%	17.4%	0.00037	0.00690
17:45-17:46	33.4	2,158,705	3,787.5	64,713.3	13.4%	73.3%	13.3%	0.00006	0.00517
17:46-17:47	31.8	2,143,603	3,755.3	67,382.4	13.3%	73.2%	13.5%	-0.00003	0.00465
17:47-17:48	32.9	2,274,094	3,826.3	69,209.9	12.9%	73.8%	13.3%	0.00008	0.00397
17:48-17:49	32.6	2,059,597	3,698.3	63,118.4	13.3%	73.5%	13.1%	0.00003	0.00474
17:49-17:50	34.9	2,302,730	3,748.7	66,049.6	13.9%	72.8%	13.3%	-0.00001	0.00490
17:50-17:51	35.0	2,568,361	4,235.9	73,322.2	13.8%	72.4%	13.8%	0.00001	0.00528
17:51-17:52	34.6	2,194,439	3,714.1	63,387.7	13.8%	72.6%	13.6%	0.00003	0.00430
17:52-17:53	37.4	2,503,544	3,828.7	67,004.8	13.2%	73.1%	13.7%	-0.00005	0.00527
17:53-17:54	35.7	2,294,651	3,747.2	64,318.9	14.1%	72.6%	13.3%	0.00006	0.00513
17:54-17:55	39.0	2,568,803	3,708.5	65,934.0	13.8%	72.8%	13.3%	0.00001	0.00514
17:55-17:56	41.9	2,774,674	3,807.4	66,233.9	13.1%	72.7%	14.2%	0.00011	0.00644
17:56-17:57	43.0	2,656,768	3,670.3	61,809.8	13.9%	72.4%	13.7%	0.00002	0.00532
17:57-17:58	44.1	2,905,867	3,743.1	65,880.8	13.8%	72.0%	14.3%	0.00019	0.00607
17:58-17:59	52.2	3,665,986	4,131.2	70,208.2	14.0%	72.0%	14.1%	0.00010	0.00609
17:59-18:00	110.0	7,856,803	4,141.1	71,403.4	15.2%	67.4%	17.4%	0.00037	0.00690
18:00-18:01	7.7	566,320	4,119.4	73,396.4	15.0%	66.3%	18.7%	0.00017	0.00593
18:01-18:02									
18:02-18:03									
18:03-18:04	47.3	14,301,203	17,646.0	302,634.6	19.7%	60.6%	19.7%	0.00024	0.02424
18:04-18:05	30.9	10,728,856	19,141.1	346,727.6	20.8%	58.9%	20.3%	-0.00027	0.02590
18:05-18:06	25.1	8,092,519	18,820.4	322,747.2	20.5%	59.3%	20.2%	0.00003	0.02342
18:06-18:07	22.3	6,069,119	14,964.7	271,590.4	19.5%	61.2%	19.3%	-0.00029	0.02106
18:07-18:08	20.3	5,410,826	15,184.0	267,051.4	19.3%	61.2%	19.5%	0.00047	0.02526
18:08-18:09	19.2	5,482,149	16,222.9	286,223.1	18.8%	62.2%	18.9%	0.00016	0.02564
18:09-18:10	17.8	3,938,577	11,747.6	220,831.3	18.5%	63.4%	18.1%	0.00009	0.02045
18:10-18:11	17.4	4,269,306	14,510.1	245,314.3	18.5%	63.8%	17.8%	-0.00040	0.01860
18:11-18:12	16.6	6,278,662	23,387.3	379,089.0	17.7%	64.8%	17.5%	-0.00015	0.01824
18:12-18:13	15.5	3,507,670	11,545.3	226,218.4	17.7%	64.2%	18.1%	-0.00012	0.01757
18:13-18:14	14.8	2,556,140	9,483.5	172,632.6	17.4%	64.9%	17.7%	-0.00012	0.01833
18:14-18:15	14.4	2,773,125	9,361.7	192,305.0	17.7%	65.3%	17.1%	-0.00020	0.01500
18:15-18:16	14.1	2,242,068	8,730.6	158,666.6	17.1%	65.1%	17.8%	0.00009	0.01697
18:16-18:17	13.3	2,537,607	10,365.2	190,862.8	16.9%	65.7%	17.4%	-0.00033	0.01527
18:17-18:18	14.1	1,986,739	8,302.3	141,279.2	16.5%	66.6%	16.9%	0.00016	0.01430

Appendix B – Internal trades 17:50-18:00

The trading intervals from which the statistics are calculated are presented in Panel's headline. Count includes all trades and "Pos+Neg" includes trades whose returns are distinct from zero. "Pos%" takes the value of positive reruns / (positive + negative returns). μ is the average return and σ is the standard deviation of returns. T-statistics is compared to Student's t-distribution with n-1 degrees of freedom. Z-statistics are calculated to test whether the proportion of positive returns differ statistically from negative returns. The proportion is defined as positive returns / (positive + negative returns). μ_0 is the assumed mean and P_0 the assumed proportion of positive returns in the given period. Significance levels above the 90% level of confidence are marked with bold.

Before-sample represents the period before the change in the evening trading rules on April 11, 2001 (August 3, 2000 – April 9, 2001) and After-sample represents the period after the change (April 11, 2001 – December 28, 2001).

EVL = Evli, ES = Enskilda, NRD = Nordea, ALF = Alfred Berg and OPS = Opstock.

BEFORE

	Count	Pos&Neg	σ	μ	μ_0	t-statistic	Pos%	P_0	z-statistic
Panel A: 17:50-18:00									
EVL	68	33	0.0109	0.00169	0.00013	1.18	60.6%	50.5%	1.16
ES	97	64	0.0178	-0.00223	0.00013	-1.31	43.8%	50.5%	-1.09
NRD	431	204	0.0168	0.00045	0.00013	0.39	53.4%	50.5%	0.83
ALF	87	35	0.0178	0.00289	0.00013	1.45	60.0%	50.5%	1.12
OPS	57	31	0.0171	-0.00242	0.00013	-1.12	48.4%	50.5%	-0.24
Panel B: 17:55-18:00									
EVL	45	23	0.0114	0.00049	0.00020	0.17	52.2%	50.9%	0.13
ES	61	39	0.0109	-0.00092	0.00020	-0.80	43.6%	50.9%	-0.91
NRD	307	151	0.0185	0.00078	0.00020	0.55	53.6%	50.9%	0.68
ALF	63	28	0.0205	0.00325	0.00020	1.18	57.1%	50.9%	0.67
OPS	44	22	0.0111	-0.00021	0.00020	-0.25	59.1%	50.9%	0.77
Panel E: 17:54-17:56									
EVL	13	8	0.0119	0.00560	0.00004	1.69	62.5%	50.0%	0.71
ES	18	9	0.0082	-0.00077	0.00004	-0.41	55.6%	50.0%	0.33
NRD	60	22	0.0179	0.00019	0.00004	0.07	45.5%	50.0%	-0.43
ALF	9	4	0.0057	0.00055	0.00004	0.27	50.0%	50.0%	0.00
OPS	9	4	0.0314	-0.01184	0.00004	-1.13	0.0%	50.0%	**-2.00**
Panel F: 17:56-17:58									
EVL	13	3	0.0056	0.00083	0.00007	0.49	33.3%	49.5%	-0.56
ES	15	10	0.0055	-0.00118	0.00007	-0.88	50.0%	49.5%	0.03
NRD	73	39	0.0088	0.00120	0.00007	1.10	56.4%	49.5%	0.87
ALF	17	8	0.0286	0.00443	0.00007	0.63	62.5%	49.5%	0.74
OPS	10	5	0.0078	0.00166	0.00007	0.65	80.0%	49.5%	1.37
Panel G: 17:58-18:00									
EVL	24	15	0.0127	-0.00152	0.00032	-0.71	53.3%	51.8%	0.12
ES	42	28	0.0124	-0.00137	0.00032	-0.89	39.3%	51.8%	-1.32
NRD	205	101	0.0200	0.00012	0.00032	-0.15	52.5%	51.8%	0.14
ALF	40	17	0.0180	0.00340	0.00032	1.08	58.8%	51.8%	0.58
OPS	29	16	0.0130	-0.00083	0.00032	-0.48	56.3%	51.8%	0.36

AFTER

	Count	Pos&Neg	σ	μ	μ_0	t-statistic	Pos%	P_0	z-statistic
Panel A: 17:50-18:00									
EVL	59	27	0.0117	-0.00012	0.00013	-0.17	51.9%	51.0%	0.09
ES	41	13	0.0059	-0.00078	0.00013	-0.99	38.5%	51.0%	-0.91
NRD	371	168	0.0092	0.00091	0.00013	1.64	55.4%	51.0%	1.12
ALF	81	32	0.0061	0.00051	0.00013	0.56	40.6%	51.0%	-1.18
OPS	55	26	0.0399	-0.00044	0.00013	-0.11	53.8%	51.0%	0.29
Panel B: 17:55-18:00									
EVL	44	23	0.0129	-0.00041	0.00020	-0.31	47.8%	51.8%	-0.38
ES	34	9	0.0062	-0.00074	0.00020	-0.89	44.4%	51.8%	-0.44
NRD	276	130	0.0076	0.00057	0.00020	0.80	55.4%	51.8%	0.81
ALF	62	24	0.0048	0.00018	0.00020	-0.04	33.3%	51.8%	-1.81
OPS	37	14	0.0077	0.00007	0.00020	-0.11	50.0%	51.8%	-0.14
Panel E: 17:54-17:56									
EVL	6	1	0.0022	0.00091	0.00006	0.93	100.0%	50.7%	0.99
ES	7	5	0.0135	-0.00383	0.00006	-0.77	20.0%	50.7%	-1.37
NRD	56	32	0.0151	0.00344	0.00006	1.68	62.5%	50.7%	1.34
ALF	12	2	0.0025	0.00090	0.00006	1.19	100.0%	50.7%	1.40
OPS	9	3	0.0384	0.01071	0.00006	0.83	33.3%	50.7%	-0.60
Panel F: 17:56-17:58									
EVL	9	4	0.0028	-0.00055	0.00010	-0.70	25.0%	50.3%	-1.01
ES	12	2	0.0017	0.00066	0.00010	1.16	100.0%	50.3%	1.41
NRD	76	33	0.0099	0.00217	0.00010	1.83	63.6%	50.3%	1.53
ALF	12	3	0.0068	0.00251	0.00010	1.24	66.7%	50.3%	0.57
OPS	8	2	0.0041	-0.00198	0.00010	-1.45	0.0%	50.3%	-1.42
Panel G: 17:58-18:00									
EVL	32	18	0.0151	-0.00057	0.00028	-0.32	50.0%	52.4%	-0.21
ES	16	3	0.0017	-0.00046	0.00028	-1.72	33.3%	52.4%	-0.66
NRD	169	82	0.0066	0.00000	0.00028	-0.57	50.0%	52.4%	-0.44
ALF	44	21	0.0044	-0.00043	0.00028	-1.08	28.6%	52.4%	**-2.19**
OPS	23	11	0.0090	0.00132	0.00028	0.55	63.6%	52.4%	0.74

Appendix C - Return statistics of GRM (μ_0=0.000, p_0=50.0%)

D_{MONTH}, $D_{QUARTER}$ and D_{YEAR} represent the last day of the month, quarter or year, respectively. $D_{TOP20VOLUME}$ represent the 20 most active stocks and $D_{TOP30VOL}$ marks the 30 highest volume days. D_{NYSE} represents the stocks, which are traded at both HEX and NYSE. "None of the above" stands for a normal return in the given period.

Count includes all trades and "Pos.+Neg." includes trades whose returns are distinct from zero. "Pos%" takes the value of positive reruns / (positive + negative returns). μ is the average return and σ is the standard deviation of the returns. T-statistics is compared to Student's t-distribution with n-1 degrees of freedom. Z-statistics are calculated to test whether the proportion of positive returns differs statistically from negative returns. The proportion is defined as positive returns / (positive + negative returns). μ_0 is the assumed mean and P_0 is the assumed proportion of positive returns. μ_0 equals to 0.0000 and P_0 to 50.0%. Significance levels above 90% level of confidence are marked with bold.

Before-sample represents the period before the change in the evening trading rules on April 11, 2001 (August 3, 2000 – April 9, 2001) and After-sample represents the period after the change (April 11, 2001 – December 28, 2001).

	BEFORE							**AFTER**						
	Count	Pos&Neg	σ	μ	t-statistic	Pos%	z-statistic	Count	Pos&Neg	σ	μ	t-statistic	Pos%	z-statistic
Pane A: 17:00-18:00														
D_{MONTH}	682	348	0.0357	0.001650	1.21	51.0%	0.54	495	278	0.0251	0.004097	**3.63**	56.2%	**2.74**
$D_{QUARTER}$	336	185	0.0387	0.004891	**2.31**	55.1%	1.85	167	94	0.0298	0.006864	**2.97**	56.3%	1.63
D_{YEAR}	115	53	0.0493	-0.001966	-0.43	46.1%	-0.84	57	31	0.0222	0.006625	**2.25**	54.4%	0.66
$D_{TOP20VOLUME}$	3,420	1,727	0.0170	0.000639	**2.20**	50.5%	0.58	2,710	1,446	0.0146	0.000962	**3.44**	53.4%	**3.50**
$D_{TOP30DAYS}$	1,414	662	0.0283	-0.000641	-0.85	46.8%	**-2.39**	627	314	0.0261	-0.000089	-0.09	50.1%	0.04
D_{NYSE}	1,004	515	0.0152	0.000679	1.41	51.3%	0.82	837	465	0.0145	0.001411	**2.82**	55.6%	**3.21**
None of the above	6,897	3,218	0.0292	-0.000387	-1.10	46.7%	**-5.55**	5,414	2,576	0.0292	-0.000366	-0.92	47.6%	**-3.56**
Pane B: 17:30-18:00														
D_{MONTH}	587	296	0.0344	0.001883	1.33	50.4%	0.21	418	228	0.0244	0.002492	**2.09**	54.5%	1.86
$D_{QUARTER}$	302	162	0.0362	0.004177	**2.00**	53.6%	1.27	145	73	0.0295	0.004760	1.94	50.3%	0.08
D_{YEAR}	103	44	0.0450	-0.003203	-0.72	42.7%	-1.48	46	23	0.0241	0.006567	1.85	50.0%	0.00
$D_{TOP20VOLUME}$	3,182	1,647	0.0144	0.000836	**3.27**	51.8%	**1.99**	2,535	1,348	0.0122	0.001201	**4.97**	53.2%	**3.20**
$D_{TOP30DAYS}$	1,163	573	0.0260	0.000488	0.64	49.3%	-0.50	516	267	0.0266	0.001294	1.11	51.7%	0.79
D_{NYSE}	938	485	0.0131	0.000640	1.49	51.7%	1.04	804	452	0.0117	0.001405	**3.41**	56.2%	**3.53**
None of the above	4,876	2,358	0.0287	0.000627	1.53	48.4%	**-2.29**	4,111	2,066	0.0273	0.001482	**3.49**	50.3%	0.33
Pane C: 17:45-18:00														
D_{MONTH}	473	230	0.0355	-0.000853	-0.52	48.6%	-0.60	387	207	0.0240	0.002920	**2.39**	53.5%	1.37
$D_{QUARTER}$	238	114	0.0382	-0.003228	-1.30	47.9%	-0.65	132	63	0.0306	0.006065	**2.28**	47.7%	-0.52
D_{YEAR}	65	14	0.0419	-0.032004	**-6.16**	21.5%	**-4.59**	36	18	0.0222	0.006672	1.81	50.0%	0.00
$D_{TOP20VOLUME}$	2,900	1,541	0.0131	0.001050	**4.31**	53.1%	**3.38**	2,583	1,368	0.0106	0.001088	**5.20**	53.0%	**3.01**
$D_{TOP30DAYS}$	960	507	0.0253	0.001914	**2.34**	52.8%	1.74	452	256	0.0261	0.002761	**2.25**	56.6%	**2.82**
D_{NYSE}	872	493	0.0122	0.001137	**2.74**	56.5%	**3.86**	945	523	0.0095	0.001010	**3.26**	55.3%	**3.29**
None of the above	3,777	1,876	0.0273	0.001447	**3.26**	49.7%	-0.41	3,264	1,655	0.0264	0.001912	**4.14**	50.7%	0.81
Pane D: 17:55-18:00														
D_{MONTH}	327	174	0.0268	0.002498	1.69	53.2%	1.16	290	150	0.0249	0.002936	**2.01**	51.7%	0.59
$D_{QUARTER}$	160	94	0.0289	0.003875	1.70	58.8%	**2.21**	96	47	0.0323	0.005463	1.66	49.0%	-0.20
D_{YEAR}	28	9	0.0479	-0.017111	-1.89	32.1%	-1.89	25	15	0.0221	0.008180	1.85	60.0%	1.00
$D_{TOP20VOLUME}$	2,475	1,340	0.0109	0.001002	**4.57**	54.1%	**4.12**	1,862	1,011	0.0097	0.001259	**5.58**	54.3%	**3.71**
$D_{TOP30DAYS}$	689	362	0.0241	0.003141	**3.43**	52.5%	1.33	272	169	0.0277	0.006088	**3.62**	62.1%	**4.00**
D_{NYSE}	770	415	0.0108	0.001036	**2.66**	53.9%	**2.16**	703	404	0.0081	0.001157	**3.79**	57.5%	**3.96**
None of the above	2,212	1,163	0.0263	0.002933	**5.25**	52.6%	**2.42**	1,823	966	0.0269	0.003228	**5.13**	53.0%	**2.55**
Pane E: 17:59-18:00														
D_{MONTH}	208	121	0.0243	0.003688	**2.19**	58.2%	**2.36**	191	100	0.0252	0.002686	1.47	52.4%	0.65
$D_{QUARTER}$	90	60	0.0266	0.007060	**2.52**	66.7%	**3.16**	67	33	0.0356	0.004945	1.14	49.3%	-0.12
D_{YEAR}	5	3	0.0781	-0.029285	-0.84	60.0%	0.45	16	10	0.0163	0.005729	1.41	62.5%	1.00
$D_{TOP20VOLUME}$	1,701	945	0.0096	0.000820	**3.54**	55.6%	**4.58**	1,339	765	0.0087	0.001344	**5.64**	57.1%	**5.22**
$D_{TOP30DAYS}$	404	209	0.0210	0.003452	**3.30**	51.7%	0.70	153	95	0.0148	0.002995	**2.50**	62.1%	**2.99**
D_{NYSE}	632	382	0.0080	0.001458	**4.58**	60.4%	**5.25**	612	369	0.0065	0.001309	**5.02**	60.3%	**5.09**
None of the above	1,028	588	0.0274	0.004397	**5.15**	57.2%	**4.62**	892	527	0.0247	0.005146	**6.21**	59.1%	**5.42**

Appendix D - Return statistics of BRM before the close – Model I (μ_0=0.000, p_0=50.0%)

The intercept stands for the normal day-end return (17:45-18:00) when big buyers or sellers of the day have not been active 15 minutes before the close or there have not been any big buyers or sellers during the day all. B_{ALL} is the return of the last 15 minutes when a broker has acquired a big net position in one stock during the day, and acts as the buying broker near the close in the last trade of the day. S_{ALL} is the return of the last 15 minutes when a broker has disposed a big net position in one stock during the day, and acts as the selling broker near the close in the last trade of the day. D_{BOTH} is the return of the last 15 minutes when both big buyer and seller in one stock make the last trade. Note, that due to the dummy variable definitions, every observed return is categorised either as an intercept return or as one of the three dummy variables' return.

μ is the average return and σ is the standard deviation of the returns. T-statistics are compared to Student's t-distribution with n-1 degrees of freedom. Z-statistics are calculated to test whether the proportion of positive returns differs statistically from negative returns. The proportion is defined as positive returns / (positive + negative returns). μ_0 is the assumed mean and P_0 is the assumed proportion of positive returns near the close μ_0 is the assumed mean and P_0 is the assumed proportion of positive returns. μ_0 equals to 0.0000 and P_0 to 50.0%. Significance levels above 90% level of confidence are marked with bold.
Before-sample represents the period before the change in the evening trading rules on April 11, 2001 (August 3, 2000 – April 9, 2001) and After-sample represents the period after the change (April 11, 2001 – December 28, 2001).

	BEFORE						AFTER					
	Count	σ	μ	t-statistic	Positive %	z-statistic	Count	σ	μ	t-statistic	Positive %	z-statistic
Panel A. Net position 20,000 €												
Intercept	1190	0.0151	0.00126	**2.86**	51.1%	0.75	790	0.0157	0.00049	0.88	50.8%	0.43
B_{ALL}	618	0.0142	0.00287	**5.02**	54.5%	**2.25**	678	0.0123	0.00244	**5.18**	56.0%	**3.15**
S_{ALL}	496	0.0133	-0.00073	-1.23	49.6%	-0.18	715	0.0133	-0.00012	-0.23	51.7%	0.93
D_{BOTH}	1054	0.0110	0.00120	**3.53**	54.2%	**2.71**	1945	0.0118	0.00078	**2.92**	51.7%	1.47
Panel B. Net position 100,000 €												
Intercept	1260	0.0156	0.00152	**3.47**	51.6%	1.13	1784	0.0150	0.00082	**2.29**	51.8%	1.56
B_{ALL}	553	0.0135	0.00238	4.15	54.2%	**2.00**	611	0.0115	0.00212	**4.55**	55.2%	**2.55**
S_{ALL}	498	0.0128	-0.00054	-0.94	49.2%	-0.36	693	0.0121	-0.00041	-0.90	49.4%	-0.34
D_{BOTH}	1047	0.0110	0.00115	**3.40**	54.2%	**2.69**	1040	0.0102	0.00098	**3.11**	53.2%	**2.05**
Panel C. Net position 150,000 €												
Intercept	1504	0.0154	0.00146	**3.68**	51.8%	1.39	2106	0.0148	0.00087	**2.71**	52.0%	1.87
B_{ALL}	499	0.0133	0.00217	**3.64**	53.1%	1.39	557	0.0107	0.00216	**4.77**	56.7%	**3.18**
S_{ALL}	491	0.0118	-0.00060	-1.12	49.9%	-0.05	636	0.0116	-0.00022	-0.47	51.9%	0.95
D_{BOTH}	864	0.0108	0.00136	**3.71**	54.7%	**2.79**	829	0.0102	0.00071	**1.99**	49.9%	-0.03
Panel D. Net position 500,000 €												
Intercept	2284	0.0148	0.00141	**4.55**	52.3%	**2.18**	3050	0.0141	0.00082	**3.21**	51.8%	**1.99**
B_{ALL}	340	0.0111	0.00180	**3.00**	53.8%	1.41	342	0.0100	0.00257	**4.75**	57.6%	**2.81**
S_{ALL}	334	0.0100	-0.00072	-1.31	48.8%	-0.44	377	0.0091	-0.00010	-0.20	52.3%	0.88
D_{BOTH}	400	0.0100	0.00146	**2.91**	55.5%	**2.20**	359	0.0080	0.00040	0.95	50.7%	0.26
Panel E. Net position 1,000,000 €												
Intercept	2666	0.0143	0.00121	**4.34**	52.0%	**2.05**	3427	0.0137	0.00077	**3.29**	51.6%	1.86
B_{ALL}	259	0.0095	0.00321	**5.43**	59.1%	**2.92**	249	0.0107	0.00221	**3.25**	55.8%	1.84
S_{ALL}	218	0.0097	-0.00114	-1.73	47.2%	-0.81	254	0.0088	0.00031	0.56	55.1%	1.63
D_{BOTH}	215	0.0100	0.00174	**2.54**	55.8%	1.70	198	0.0065	0.00112	**2.42**	55.1%	1.42
Panel F. Net position 1,500,000 €												
Intercept	2866	0.0141	0.00121	**4.57**	52.4%	**2.58**	3598	0.0135	0.00080	**3.53**	51.6%	**1.97**
B_{ALL}	185	0.0095	0.00277	**3.96**	56.8%	1.84	209	0.0092	0.00110	1.73	55.0%	1.45
S_{ALL}	161	0.0087	-0.00111	-1.63	43.5%	-1.66	187	0.0086	0.00093	1.48	57.2%	**1.97**
D_{BOTH}	146	0.0096	0.00260	**3.27**	58.2%	**1.99**	134	0.0070	0.00162	**2.69**	56.7%	1.55

Appendix E – Results of BRM before the close – Model II

The intercept stands for the normal day-end return (17:45-18:00) when big buyers or sellers of the day have not been active 15 minutes before the close or there have not been any big buyers or sellers during the day all. B_{ALL} variable takes the value of (broker's buys / all trades in the last 15 minutes, 17:45-18:00) when a broker has acquired a big net position in one stock during the day, and acts as the buying broker near the close in the last trade of the day. S_{ALL} variable takes the value of (broker's sells / all trades in the last 15 minutes, 17:45-18:00) when a broker has disposed a big net position in one stock during the day, and acts as the selling broker near the close in the last trade of the day. D_{BOTH} variable takes the value of one when both big buyer and seller have been active in the last 15 minutes. D_{BOTH} variable takes the value of one when both big buyer and seller have been active near the close. Each column represents different net position sizes that were used to define whether a broker was a big buyer or seller. Significance levels above 90% level of confidence are marked with bold.
Before-sample represents the period before the change in the evening trading rules on April 11, 2001 (August 3, 2000 – April 9, 2001) and After-sample represents the period after the change (April 11, 2001 – December 28, 2001).

	BEFORE						AFTER					
	20,000€	100,000€	150,000€	500,000€	1,000,000€	1,500,000€	20,000€	100,000€	150,000€	500,000€	1,000,000€	1,500,000€
Intercept	0.0004	0.0011	0.0011	0.0013	0.0012	0.0012	0.0007	0.0008	0.0009	0.0008	0.0007	0.0007
	(0.33)	**(2.10)**	**(2.49)**	**(4.02)**	**(4.18)**	**(4.56)**	(0.93)	**(2.00)**	**(2.65)**	**(3.15)**	**(2.90)**	**(2.89)**
B_{ALL}	0.0014	-0.0019	-0.0027	0.0006	0.0021	0.0026	-0.0012	0.0011	0.0007	-0.0004	-0.0010	-0.0012
	(0.67)	-(1.25)	-(1.69)	(0.32)	(0.90)	(0.90)	-(0.79)	(0.90)	(0.52)	-(0.22)	-(0.37)	-(0.38)
S_{ALL}	-0.0001	-0.0028	-0.0026	-0.0040	-0.0036	-0.0042	-0.0014	-0.0033	-0.0022	-0.0012	-0.0031	0.0009
	-(0.03)	-(1.67)	-(1.64)	**-(2.08)**	-(1.61)	-(1.55)	-(0.92)	**-(2.93)**	-(1.87)	-(0.70)	-(1.28)	(0.30)
D_{BOTH}	0.0009	0.0004	0.0005	0.0001	0.0003	0.0002	0.0003	0.0003	0.0001	0.0002	0.0009	0.0010
	(0.73)	(0.76)	(0.94)	(0.27)	(0.61)	(0.31)	(0.32)	(0.75)	(0.17)	(0.56)	(1.84)	(1.92)
F-value	0.313	**2.480**	**2.977**	1.622	1.331	1.144	1.077	**4.344**	1.460	0.330	1.888	1.319
R^2	0.017	0.047	0.052	0.038	0.034	0.032	0.028	0.056	0.033	0.015	0.037	0.031
N	3,354	3,354	3,354	3,354	3,354	3,354	4,124	4,124	4,124	4,124	4,124	4,124

Appendix F – Results of BRM extension before the close – Model I

The intercept stands for the normal day-end return (17:45-18:00) when big buyers or sellers of the day have not been active 15 minutes before the close or there have not been any big buyers or sellers during the day all. B_i variable takes the value of one when a broker has acquired a big net position in one stock during the day, and acts as the buying broker near the close (17:45-18:00) in the last trade of the stock at hand. S_i variable takes the value of one when a broker has disposed a big net position in one stock during the day, and acts as the selling broker near the close in the last trade of the stock at hand. In BRM extension, five brokers are investigated in more detail. These brokers are EVL=Evli, ES= Enskilda, NRD=Nordea, ALF=Alfred Berg, OPS=Opstock). Therefore, B_{OTHER} and S_{OTHER} stands for all other brokers. D_{BOTH} variable takes the value of one when both big buyer and seller make the last trade. Each column represents different net position sizes that were used to define whether a broker was a big buyer or seller. Significance levels above the 90% level of confidence are marked with bold.

Before-sample represents the period before the change in the evening trading rules on April 11, 2001 (August 3, 2000 – April 9, 2001) and After-sample represents the period after the change (April 11, 2001 – December 28, 2001).

	BEFORE						AFTER					
	20,000€	100,000€	150,000€	500,000€	1,000,000€	1,500,000€	20,000€	100,000€	150,000€	500,000€	1,000,000€	1,500,000€
Intercept	0.0013	0.0015	0.0015	0.0014	0.0012	0.0012	0.0005	0.0008	0.0009	0.0008	0.0008	0.0008
	(3.21)	**(3.99)**	**(4.19)**	**(4.97)**	**(4.60)**	**(4.77)**	(1.07)	**(2.66)**	**(3.08)**	**(3.48)**	**(3.46)**	**(3.67)**
B_{EVL}	0.0028	0.0022	0.0004	-0.0002	-0.0001	0.0022	0.0061	0.0015	0.0022	0.0021	0.0009	0.0012
	(1.24)	(0.92)	(0.16)	-(0.08)	-(0.03)	(0.58)	**(3.75)**	(0.91)	(1.25)	(0.91)	(0.34)	(0.42)
B_{ES}	0.0039	0.0014	0.0016	0.0021	0.0029	0.0012	0.0010	0.0048	-0.0001	-0.0014	-0.0029	-0.0044
	(2.10)	(0.74)	(0.87)	(1.03)	(1.24)	(0.45)	(0.48)	**(2.73)**	-(0.05)	-(0.69)	-(1.32)	-(1.71)
B_{NRD}	0.0001	0.0006	-0.0001	-0.0023	0.0002	-0.0017	0.0005	0.0020	0.0013	0.0029	0.0021	0.0010
	(0.07)	(0.36)	-(0.07)	-(1.17)	(0.07)	-(0.69)	(0.40)	(1.51)	(0.95)	(1.74)	(1.12)	(0.55)
B_{ALF}	0.0046	0.0045	0.0046	0.0030	0.0039	0.0031	0.0009	0.0007	0.0011	0.0026	0.0029	0.0029
	(2.42)	**(2.52)**	**(2.40)**	(1.29)	(1.47)	(0.93)	(0.50)	(0.37)	(0.60)	(1.03)	(1.10)	(0.96)
B_{OPS}	-0.0044	-0.0014	0.0011	0.0003	0.0029	0.0026	0.0001	0.0029	-0.0015	0.0024	0.0029	-0.0009
	-(2.13)	-(0.54)	(0.38)	(0.07)	(0.68)	(0.43)	(0.05)	(1.08)	-(0.52)	(0.60)	(0.64)	-(0.16)
B_{OTHER}	0.0017	0.0002	0.0000	0.0003	0.0022	0.0023	0.0021	0.0004	0.0016	0.0019	0.0023	0.0006
	(2.14)	(0.23)	(0.01)	(0.24)	(1.79)	(1.62)	**(2.54)**	(0.50)	(1.96)	(1.81)	(1.78)	(0.42)
S_{EVL}	-0.0038	-0.0036	-0.0011	-0.0010	0.0007	0.0011	-0.0069	-0.0019	-0.0043	-0.0040	-0.0015	-0.0008
	-(1.86)	-(1.83)	-(0.55)	-(0.46)	(0.27)	(0.39)	**-(4.21)**	-(1.17)	**-(2.38)**	-(1.69)	-(0.48)	-(0.21)
S_{ES}	-0.0035	-0.0022	-0.0027	-0.0041	-0.0040	-0.0024	-0.0013	0.0001	-0.0009	0.0013	0.0009	0.0055
	-(1.78)	-(1.38)	-(1.73)	**-(2.31)**	-(1.65)	-(0.88)	-(0.69)	(0.04)	-(0.58)	(0.62)	(0.35)	(1.68)
S_{NRD}	0.0034	0.0034	0.0027	-0.0011	-0.0054	-0.0047	-0.0006	-0.0001	-0.0006	-0.0016	-0.0017	-0.0017
	(1.44)	(1.55)	(1.25)	-(0.42)	-(1.42)	-(0.97)	-(0.42)	-(0.04)	-(0.42)	-(0.84)	-(0.85)	-(0.82)
S_{ALF}	-0.0057	-0.0041	-0.0040	-0.0025	-0.0015	-0.0011	-0.0004	-0.0029	0.0005	-0.0007	-0.0003	-0.0005
	-(2.74)	**-(2.25)**	**-(2.32)**	-(1.22)	-(0.57)	-(0.35)	-(0.21)	-(1.63)	(0.27)	-(0.29)	-(0.11)	-(0.18)
S_{OPS}	-0.0033	-0.0042	-0.0041	-0.0034	-0.0030	0.0022	0.0005	-0.0009	0.0011	-0.0012	-0.0008	0.0037
	-(1.03)	-(1.30)	-(1.25)	-(0.75)	-(0.55)	(0.16)	(0.22)	-(0.35)	(0.36)	-(0.26)	-(0.18)	(0.70)
S_{OTHER}	-0.0015	-0.0020	-0.0022	-0.0016	-0.0024	-0.0032	0.0004	-0.0014	-0.0011	-0.0007	-0.0002	0.0000
	-(1.70)	**-(2.13)**	**-(2.32)**	-(1.46)	-(1.87)	**-(2.21)**	(0.47)	-(1.95)	-(1.47)	-(0.83)	-(0.18)	(0.01)
D_{BOTH}	-0.0001	-0.0004	-0.0001	0.0001	0.0005	0.0014	0.0003	0.0002	-0.0002	-0.0004	0.0003	0.0008
	-(0.10)	-(0.65)	-(0.17)	(0.07)	(0.55)	(1.21)	(0.53)	(0.33)	-(0.31)	-(0.57)	(0.37)	(0.72)
F-value	**3.431**	**2.180**	1.892	1.074	1.311	1.029	**3.357**	1.659	1.283	1.119	0.707	0.699
R^2	0.115	0.092	0.085	0.064	0.071	0.063	0.102	0.072	0.064	0.059	0.047	0.047
N	3,344	3,344	3,344	3,344	3,344	3,344	4,114	4,114	4,114	4,114	4,114	4,114

Appendix G - Return statistics of BRM after the close – Model I (μ_0=0.000, p_0=50.0%)

The intercept stands for a normal return of the first 15 evening trading minutes (18:03-18:18) when big buyers or sellers have not been active near the close (17:45-18:00) or there have not been any big buyers or sellers during the day at all. B_{ALL} is the return of the first 15 evening trading minutes when a broker has acquired a big net position in one stock during the day, and acts as the buying broker near the close in the last trade of the day. S_{ALL} is the return of the first 15 evening trading minutes when a broker has disposed a big net position in one stock during the day, and acts as the selling broker near the close in the last trade of the day. D_{BOTH} is the return of the first 15 evening trading minutes when both big buyer and seller in one stock make the last trade. Note, that due to the dummy variable definitions, every return is categorised either as an intercept return or as one of the three dummy variables' return.

μ is the average return and σ is the standard deviation of the returns. T-statistics are compared to Student's t-distribution with n-1 degrees of freedom. Z-statistics are calculated to test whether the proportion of positive returns differs statistically significantly from negative returns. The proportion is defined as positive returns / (positive + negative returns). μ_0 is the assumed mean and P_0 is the assumed proportion of positive returns of first 15 evening trading minutes. μ_0 is the assumed mean and P_0 is the assumed proportion of positive returns. μ_0 equals to 0.0000 and P_0 to 50.0%. Significance levels above 90% level of confidence are marked with bold.

Before-sample represents the period before the change in the evening trading rules on April 11, 2001 (August 3, 2000 – April 9, 2001) and After-sample represents the period after the change (April 11, 2001 – December 28, 2001).

	BEFORE						AFTER					
	Count	σ	μ	t-statistic	Positive %	z-statistic	Count	σ	μ	t-statistic	Positive %	z-statistic
Panel A. Net position 20,000 €												
Intercept	438	0.0162	-0.00006	-0.07	52.9%	1.23	271	0.0153	-0.00027	-0.29	52.0%	0.67
B_{ALL}	538	0.0302	0.00002	0.02	48.9%	-0.53	312	0.0092	0.00012	0.22	48.7%	-0.45
S_{ALL}	391	0.0228	0.00094	0.81	54.9%	1.93	299	0.0117	0.00020	0.29	46.5%	-1.21
D_{BOTH}	1346	0.0246	-0.00041	-0.61	50.4%	0.30	802	0.0111	0.00004	0.10	48.3%	-0.99
Panel B. Net position 100,000 €												
Intercept	939	0.0204	0.00006	0.08	51.9%	1.18	538	0.0141	0.00079	1.29	52.2%	1.03
B_{ALL}	476	0.0305	-0.00163	-1.16	49.3%	-0.30	288	0.0121	-0.00153	**-2.14**	44.4%	-1.89
S_{ALL}	413	0.0259	0.00047	0.37	54.2%	1.72	313	0.0107	0.00135	**2.22**	49.8%	-0.06
D_{BOTH}	885	0.0237	0.00031	0.39	49.9%	-0.04	545	0.0089	-0.00065	-1.72	46.4%	-1.67
Panel C. Net position 150,000 €												
Intercept	1119	0.0214	0.00041	0.65	52.5%	1.70	644	0.0142	0.00061	1.09	52.5%	1.26
B_{ALL}	434	0.0319	-0.00314	**-2.05**	48.0%	-0.85	275	0.0087	-0.00109	**-2.07**	45.5%	-1.51
S_{ALL}	418	0.0272	0.00099	0.75	53.9%	1.59	307	0.0105	0.00082	1.37	48.5%	-0.51
D_{BOTH}	742	0.0217	0.00014	0.17	49.6%	-0.19	458	0.0098	-0.00065	-1.42	45.2%	**-2.06**
Panel D. Net position 500,000 €												
Intercept	1739	0.0247	0.00037	0.62	52.2%	1.87	981	0.0135	0.00055	1.27	51.9%	1.18
B_{ALL}	305	0.0264	-0.00368	**-2.44**	48.6%	-0.50	224	0.0092	-0.00191	**-3.12**	42.4%	**-2.27**
S_{ALL}	301	0.0256	0.00100	0.68	50.6%	0.21	227	0.0087	0.00048	0.82	47.1%	-0.86
D_{BOTH}	368	0.0238	-0.00031	-0.25	49.4%	-0.25	252	0.0076	-0.00065	-1.36	42.9%	**-2.27**
Panel E. Net position 1,000,000 €												
Intercept	2067	0.0254	0.00029	0.52	52.3%	**2.06**	1162	0.0130	0.00057	1.50	51.6%	1.11
B_{ALL}	234	0.0232	-0.00293	-1.93	47.0%	-0.92	189	0.0086	-0.00174	**-2.77**	42.3%	**-2.11**
S_{ALL}	206	0.0282	-0.00101	-0.51	48.8%	-0.33	187	0.0079	-0.00104	-1.81	39.6%	**-2.85**
D_{BOTH}	206	0.0219	0.00015	0.10	48.9%	-0.33	146	0.0073	-0.00060	-1.00	44.5%	-1.32
Panel F. Net position 1,500,000 €												
Intercept	2244	0.0255	0.00015	0.28	52.0%	1.88	1269	0.0128	0.00044	1.23	50.7%	0.53
B_{ALL}	170	0.0241	-0.00126	-0.68	50.7%	0.18	161	0.0073	-0.00117	**-2.03**	43.5%	-1.66
S_{ALL}	154	0.0277	-0.00212	-0.95	46.7%	-0.83	142	0.0071	-0.00171	**-2.85**	39.4%	**-2.52**
D_{BOTH}	145	0.0219	-0.00027	-0.15	45.7%	-1.04	112	0.0073	-0.00069	-0.99	43.8%	-1.32

Appendix H – Results of BRM after the close – Model II

The intercept stands for a normal return of the first 15 evening trading minutes (18:03-18:18) when big buyers or sellers have not been active near the close (17:45-18:00) or there have not been any big buyers or sellers during the day at all. B_{ALL} variable takes the value of (broker's buys / all trades in the last 15 minutes, 17:45-18:00) when a broker has acquired a big net position in one stock during the day, and acts as the buying broker near the close in the last trade of the day. S_{ALL} variable takes the value of (broker's sells / all trades in the last 15 minutes, 17:45-18:00) when a broker has disposed a big net position in one stock during the day, and acts as the selling broker near the close in the last trade of the day. D_{BOTH} variable takes the value of one when both big buyer and seller have been active near the close. D_{BOTH} variable takes the value of one when both big buyer and seller have been active near the close. Each column represents different net position sizes that were used to define whether a broker was a big buyer or seller. Significance levels above 90% level of confidence are marked with bold. Before-sample represents the period before the change in the evening trading rules on April 11, 2001 (August 3, 2000 – April 9, 2001) and After-sample represents the period after the change (April 11, 2001 – December 28, 2001).

	BEFORE						AFTER					
	20,000€	100,000€	150,000€	500,000€	1,000,000€	1,500,000€	20,000€	100,000€	150,000€	500,000€	1,000,000€	1,500,000€
Intercept	0.0010	0.0003	0.0010	0.0006	0.0009	0.0002	0.0010	0.0010	0.0008	0.0008	0.0010	0.0009
	(0.38)	(0.24)	(1.04)	(0.88)	(1.42)	(0.37)	(0.57)	(1.37)	(1.34)	(1.87)	**(2.41)**	**(2.32)**
B_{ALL}	-0.0070	-0.0007	-0.0019	-0.0095	-0.0122	-0.0066	0.0007	-0.0028	-0.0004	-0.0010	-0.0025	-0.0023
	-(1.54)	-(0.25)	-(0.64)	**-(2.31)**	**-(2.76)**	-(1.27)	(0.20)	-(1.18)	-(0.16)	-(0.33)	-(0.59)	-(0.50)
S_{ALL}	-0.0029	0.0045	0.0031	0.0013	-0.0056	-0.0044	-0.0031	0.0043	0.0037	0.0058	0.0009	-0.0022
	-(0.54)	(1.37)	(0.97)	(0.32)	-(1.26)	-(0.87)	-(0.84)	(1.93)	(1.76)	**(2.16)**	(0.27)	-(0.63)
D_{BOTH}	-0.0009	-0.0006	-0.0017	-0.0012	-0.0019	-0.0005	-0.0010	-0.0013	-0.0013	-0.0017	-0.0021	-0.0021
	-(0.35)	-(0.49)	-(1.46)	-(1.15)	-(1.78)	-(0.42)	-(0.57)	-(1.67)	-(1.78)	**-(2.83)**	**-(3.56)**	**-(3.53)**
F-value	1.113	0.978	1.473	**2.091**	**3.526**	0.774	0.405	**3.763**	**3.300**	**5.253**	**4.445**	**4.183**
R^2	0.035	0.033	0.040	0.048	0.062	0.029	0.027	0.082	0.077	0.096	0.089	0.086
N	2,709	2,709	2,709	2,709	2,709	2,709	1,680	1,680	1,680	1,680	1,680	1,680

Appendix I – Results of BRM extension after the close – Model I

The intercept stands for a normal return of the first 15 evening trading minutes (18:03-18:18) when big buyers or sellers have not been active near the close (17:45-18:00) or there have not been any big buyers or sellers during the day at all. B_i variable takes the value of one when a broker has acquired a big net position in one stock during the day, and acts as the buying broker near the close (17:45-18:00) in the last trade of the stock at hand. S_i variable takes the value of one when a broker has disposed a big net position in one stock during the day, and acts as the selling broker near the close in the last trade of the stock at hand. In BRM extension, five brokers are investigated in more detail. These brokers are EVL=Evli, ES= Enskilda, NRD=Nordea, ALF=Alfred Berg, OPS=Opstock. Therefore, B_{OTHER} and S_{OTHER} stands for all other brokers. D_{BOTH} variable takes the value of one when both big buyer and seller make the last trade. Each column represents different net position sizes that were used to define whether a broker was a big buyer or seller. Significance levels above the 90% level of confidence are marked with bold.

Before-sample represents the period before the change in the evening trading rules on April 11, 2001 (August 3, 2000 – April 9, 2001) and After-sample represents the period after the change (April 11, 2001 – December 28, 2001).

	BEFORE						AFTER					
	20,000€	100,000€	150,000€	500,000€	1,000,000€	1,500,000€	20,000€	100,000€	150,000€	500,000€	1,000,000€	1,500,000€
Intercept	-0.0001	0.0001	0.0005	0.0004	0.0003	0.0002	-0.0003	0.0008	0.0006	0.0005	0.0006	0.0004
	-(0.11)	(0.10)	(0.72)	(0.66)	(0.54)	(0.29)	-(0.38)	(1.57)	(1.33)	(1.47)	(1.67)	(1.35)
B_{EVL}	0.0025	0.0022	0.0021	0.0006	-0.0024	-0.0040	-0.0001	-0.0035	-0.0031	-0.0031	-0.0028	-0.0013
	(0.53)	(0.44)	(0.43)	(0.09)	-(0.38)	-(0.51)	-(0.05)	-(1.72)	-(1.47)	-(1.26)	-(1.05)	-(0.43)
B_{ES}	-0.0038	-0.0134	-0.0130	-0.0166	-0.0114	-0.0044	-0.0018	-0.0098	0.0007	-0.0020	-0.0026	-0.0024
	-(0.93)	**-(3.35)**	**-(3.46)**	**-(4.00)**	**-(2.22)**	-(0.76)	-(0.61)	**-(3.72)**	(0.25)	-(0.79)	-(1.03)	-(0.88)
B_{NRD}	-0.0019	-0.0002	-0.0015	-0.0001	-0.0015	-0.0023	0.0008	-0.0012	-0.0018	-0.0030	-0.0011	-0.0008
	-(0.52)	-(0.06)	-(0.42)	-(0.02)	-(0.36)	-(0.47)	(0.43)	-(0.69)	-(0.95)	-(1.46)	-(0.53)	-(0.39)
B_{ALF}	-0.0049	-0.0096	-0.0105	-0.0076	-0.0129	-0.0096	0.0004	-0.0026	-0.0005	-0.0018	-0.0019	-0.0014
	-(1.19)	**-(2.42)**	**-(2.63)**	-(1.55)	**-(2.50)**	-(1.54)	(0.14)	-(1.02)	-(0.23)	-(0.68)	-(0.75)	-(0.48)
B_{OPS}	0.0031	0.0043	0.0001	-0.0054	-0.0072	-0.0058	0.0024	-0.0027	-0.0030	-0.0026	-0.0029	-0.0038
	(0.71)	(0.79)	(0.02)	-(0.76)	-(0.80)	-(0.51)	(0.98)	-(0.75)	-(0.92)	-(0.67)	-(0.70)	-(0.72)
B_{OTHER}	0.0011	0.0001	-0.0021	-0.0020	0.0000	0.0017	0.0003	-0.0013	-0.0018	-0.0024	-0.0027	-0.0018
	(0.61)	(0.07)	-(1.15)	-(0.95)	(0.02)	(0.61)	(0.26)	-(1.26)	-(1.65)	**-(2.06)**	**-(2.03)**	-(1.24)
S_{EVL}	-0.0017	0.0029	0.0007	0.0016	-0.0018	-0.0029	-0.0004	-0.0024	0.0002	0.0005	-0.0024	-0.0020
	-(0.39)	(0.73)	(0.17)	(0.37)	-(0.36)	-(0.53)	-(0.19)	-(1.11)	(0.07)	(0.19)	-(0.75)	-(0.55)
S_{ES}	0.0032	0.0032	0.0038	0.0001	-0.0053	-0.0010	-0.0014	0.0010	-0.0018	0.0004	-0.0012	-0.0022
	(0.74)	(0.96)	(1.16)	(0.02)	-(1.13)	-(0.18)	-(0.50)	(0.46)	-(0.89)	(0.15)	-(0.43)	-(0.71)
S_{NRD}	-0.0020	-0.0046	-0.0037	-0.0040	0.0029	0.0064	-0.0020	0.0022	-0.0004	-0.0014	-0.0024	-0.0018
	-(0.40)	-(1.00)	-(0.80)	-(0.73)	(0.41)	(0.70)	-(0.97)	(1.08)	-(0.20)	-(0.64)	-(1.10)	-(0.80)
S_{ALF}	0.0042	0.0024	-0.0030	-0.0074	-0.0171	-0.0215	0.0039	0.0029	0.0023	0.0018	-0.0009	-0.0007
	(0.93)	(0.64)	-(0.83)	-(1.75)	**-(3.19)**	**-(3.35)**	(1.28)	(1.36)	(0.91)	(0.71)	-(0.38)	-(0.23)
S_{OPS}	0.0029	-0.0188	-0.0103	0.0077	0.0114	-0.0077	0.0004	-0.0020	0.0023	0.0088	0.0088	0.0031
	(0.42)	**-(2.73)**	-(1.49)	(0.90)	(1.09)	-(0.30)	(0.14)	-(0.65)	(0.58)	(1.68)	(1.68)	(0.60)
S_{OTHER}	0.0009	0.0006	0.0015	0.0029	0.0021	0.0004	0.0010	0.0005	0.0004	-0.0006	-0.0021	-0.0031
	(0.45)	(0.30)	(0.81)	(1.30)	(0.82)	(0.15)	(0.90)	(0.45)	(0.38)	-(0.52)	-(1.67)	**-(2.10)**
D_{BOTH}	-0.0003	0.0002	-0.0004	-0.0007	-0.0001	-0.0004	0.0003	-0.0014	-0.0013	-0.0012	-0.0012	-0.0011
	-(0.19)	(0.19)	-(0.34)	-(0.49)	-(0.08)	-(0.19)	(0.38)	**-(2.04)**	-(1.76)	-(1.45)	-(1.14)	-(0.98)
F-value	0.523	**2.260**	**2.002**	**2.013**	1.953	1.243	0.437	**2.183**	0.843	1.051	1.066	0.694
R^2	0.050	0.104	0.098	0.098	0.097	0.077	0.058	0.129	0.081	0.090	0.091	0.073
N	2,699	2,699	2,699	2,699	2,699	2,699	1,670	1,670	1,670	1,670	1,670	1,670

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